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Florida Academy of Sciences

for

1939

VOLUME 4

Published by the Academy, Gainesville, Florida

August, 1940

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PROCEEDINGS OF THE FLORIDA ACADEMY OF SCIENCES

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PROCEEDINGS OF
THE FLORIDA ACADEMY OF SCIENCES

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SCIENTISTS AND SOCIAL PROGRESS*

B. P. REINSCH
Florida Southern College

CRITICISMS OF SCIENCE

In these recent years of economic difficulties and social injustices, it has become the fashion to direct varied accusations and criticisms against science. The many applications of scientific knowledge to human affairs, admittedly valuable in themselves, and tending to give man control over his environment, are being held responsible for many of our present-day evils. Here are some of the things they say: Technological advances produce unemployment. Mechanization of agriculture leads to overproduction. Science and invention produce more and more ingenious machines of destruction so that a future war will very likely destroy our civilization. The widespread fruits of science encourage an excessive worship of the material and tend to make mankind spiritually bankrupt. Science should take a ten-year holiday, give man time to catch up morally and ethically. Science has failed to solve the pressing problems of human needs and human relationships.

These criticisms have all been aptly summarized by Harold G. Moulton in his address on "Science and Society" to the American Association for the Advancement of Science in Indianapolis:[1]

> In what concrete ways is science held to be a menace—a threat to the future of civilization? At its door various commentators, reflecting upon the undisciplined progress of the past 100 years, have placed responsibility: for developing an industrial organization of such vast complexity as to baffle human control; for creating an international economic structure in a world of political nationalism; for building implements of warfare which threaten the very extinction of peoples; for so mechanizing work processes as to dull the qualities of human intelligence; for changing the relative rates of population growth in the upper and lower strata of society; for bringing into existence new forms of goods and services in such rapid succession and in such profusion as to make it difficult for slowly changing human beings to assimilate them; for giving us leisure that we do not know how

*Address of the retiring president.

[1]*Science*, Vol. 87 (Feb. 25, 1938), p. 174.

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to use; for producing chronic unemployment and the grave social problems which it entails; for building up a capacity for production beyond our powers of consumption; for creating an artificial way of life in place of the old simplicity; and for distorting ethical values and undermining religion and morals.

Meanwhile, the ambitions of science are not being realized; indeed, there is a deep feeling of frustration. Applications of new knowledge and inventions to productive processes are delayed by restrictive business practices and governmental regulations and especially by great economic dislocations which thwart the profit incentive and at the same time diminish the financial resources required for continuing research.

SCIENTISTS DEFEND SCIENCE

To meet these accusations, scientists are naturally becoming quite vociferous in defense of science. They point out that "Science Makes Jobs"—witness the automobile, the telephone, the chemical and the electrical industries. They list the many beneficial effects of scientific discoveries upon society. They explain that the machines and products of science can be used either for noble or for nefarious purposes. For example, the same materials are used to make both gunpowder and fertilizers; even high explosives have many peace-time uses. Science is knowledge only. It is not concerned with the uses that are made of this knowledge. The right use is a matter of morality and religion. The scientist is not responsible for the misuse of his gifts; let society take care of that.

Much of this defense has really proven to be quite incomplete and unsatisfying. For example, the argument that science makes jobs isn't very helpful when we consider that there are still about 10,000,000 unemployed. Science has helped make this a land of plenty; yet, paradoxically, millions are in dire need of the bare necessities of life.

GROWING INTEREST IN SOCIAL PROGRESS

Men of science are beginning to bestir themselves and coming to realize their special responsibilities in the solution of social problems. For example: The International Council of Scientific Unions in May, 1937, instituted a Committee on Science and its Social Relations with Prof. J. M. Burgers of Delft, Holland, as Secretary. They are planning extensive world questionnaires to investigate among other things: "the part played by scientific thought in the outlook of various social groups; the forms in which scientific workers and their work are involved in the various struggles and conflicts of human society; the forms in which the consciousness of a social responsibility of science and of scientific workers is taking shape."[2]

[2]*Science News Letter,* Vol. 34 (Oct. 15, 1938), p. 248.

In December, 1938, scientists in Boston and Cambridge, Mass., organized[3] another branch of the American Association of Scientific Workers with the purpose of bringing scientific workers together to promote an understanding of the relationship between science and social problems.

The aims of this American Association parallel closely those of the Association of Scientific Workers, organized in Great Britain in 1918. Their president, Sir F. Gowland Hopkins, past president of the British Association for the Advancement of Science and of the Royal Society, wrote a congratulatory letter to the American Association of Scientific Workers saying: "In these days when science plays so great a part in every field of modern life it is essential for scientific workers to organize, both to protect their own economic and professional status and to work for the better organization and application of science for the benefit of the community."[4]

Our American Association for the Advancement of Science has begun with the Indianapolis meeting[5] in 1937 the practice of scheduling many addresses and symposia on this vital problem of the interrelationships of science and society.

The actions of these groups testify to a growing interest in social problems. Yet I think we will agree that the great majority of our scientific workers have assumed little responsibility or shown little interest thus far.

RESPONSIBILITY FOR SOCIAL PROGRESS

On what grounds should we expect scientists to participate more actively in the solution of our many human problems: social, economic, and political? Scientists have with their discoveries and developments made the greatest contributions toward creation of the modern order with its problems. To refuse to play an active part in the solution of these problems would be tantamount to a betrayal of the scientific movement. In sheer self-defense scientists must become active.

The fundamental reason for the scientist's social responsibility lies in the fact that he lives in a democracy. He is a vital part of it. As a citizen, with an intelligence high above the average, he has greater responsibilities than merely voting, accepting majority rule, and understanding governmental processes. His own welfare is intimately wrapped up in the welfare of his country. He needs to keep informed regarding

[3] *Science*, Vol. 88 (Dec. 16, 1938), p. 562.
[4] *Science*, Vol. 89 (Jan. 20, 1939), p. 58.
[5] *Science*, Vol. 87 (Feb. 25, 1938), pp. 173-179.

public issues in local, state, and national affairs, to arrive at intelligent convictions, and to give vigorous expression to them. He must give guiding principles to the masses, help them to understand the complex and confusing issues, and enable them to distinguish between the genuine and the counterfeit. He will need to cooperate actively with other citizens in carrying on the necessary work of the community and nation.

There is another reason why the scientist has a special responsibility. That is his peculiar intellectual equipment. His habits of careful and impartial investigation, his conviction that nature is orderly and understandable, his habit of subjecting hypotheses to the test of irreducible and stubborn facts, his passion for truth, his unwillingness to manipulate the truth for the sake of doctrine, his knowledge that it is impossible to get something for nothing—all these qualities make him peculiarly valuable in social and economic affairs.

Our country needs the services of that type of man. This thought was already voiced in a prophetic statement of James Madison: "the task of adapting institutions and laws to the intellectual, moral, and social changes to come in 1930 will require for the task all the wisdom of the wisest patriots."

THE INDIVIDUAL SCIENTISTS AND SOCIAL PROGRESS

We should stop for a moment to say what we mean by social progress. It does not merely denote a change to a new order. Change is commonly mistaken for progress. Progress requires the new order to be superior to the old. We might say that progress is that which secures an increase in human happiness, that which advances toward a more desirable type of living. We shall now discuss a few specific ways in which the individual scientist may become a more helpful factor in social progress.

1. *Scientists need to educate the people as to the true character of their scientific work.* Most ordinary persons take the many wonderful gifts of science for granted. All too few have a realization of the fundamental way in which science is responsible for the innumerable good things in man's life and in man's way of thinking. Think of the many *immediate social benefits* of researches in soil chemistry, food chemistry, horticulture, entomology, bacteriology, metallurgy and the like.

The scientist should pass along to the people information concerning the present-day attempts of scientists to solve certain social problems. For example, how many people know that a Science Committee of the National Resources Committee is making studies of technological trends and recommending national policies for meeting the problems of technological unemployment?

How many know of the present attempts of certain technical schools to give their students not only work in their special sciences but also a substantial amount of work in the social sciences (economics, sociology, history, etc.) in order to produce men of social vision and sound training—men who will have a definite understanding of the problems awaiting them in industry and society?

Then, the common man should be made to realize that there can be *no stopping of scientific research*—that not only is it a normal human activity in response to natural curiosity, but also it is being urgently demanded by society to give more knowledge to doctor, engineer, manufacturer, farmer, economist, psychologist, etc. Most scientists believe, not that there is today too much science, but rather that the scientific attitude—the essence of science—is far too little understood and too inadequately applied to human problems. In the words of Albert R. Mann in his Report on the Program in Southern Education: "Most obviously the sciences are destined to play an increasing part in the progress of the South as the years pass."[6]

In this connection, warning should be given that our social problems are not going to be solved by the development and extension of scientific knowledge alone, but that a decided change in mental attitude, a spirit of brotherhood, and a desire for social justice are also needed.

2. *Scientists need to become more interested in social problems.* They must demonstrate that they have a vital interest in, and a human concern for, the problems of society. Many will need a radical reconstruction of their attitudes—their desires to be left alone in their scientific cloisters, out of touch with the world about them, completely absorbed in the advancing of the frontiers of scientific knowledge. They will need to come out occasionally—to look about them—to make note of various problems of the community, state, and nation. Is the government efficient and honest? If not, why not? What about improving housing and employment conditions? Is improvement needed in the local schools, local health conditions, opportunities for recreation, and so on without end? The reason why certain political subdivisions often elect to do the foolish and unwise thing is because the simple everyday issues in economic and political questions are often too complex and involved to be understood by the untrained and uninformed minds. What can be expected if the cultivated minds of the community do not attempt to clarify issues or call attention to advantages, disadvantages, or dangers?

3. *To help solve social problems, the scientist must study them carefully.* He must avoid approaching the problem with a superior air,

[6]General Education Board, Annual Report, 1938 (New York), pp. 5-63.

thinking the answers will be immediately forthcoming because of his scientific methods of attack. He will find the social problems much more difficult than the problems in the physical and biological sciences because of the numerous contributing factors and the unpredictable human element. As an illustration, consider the problem of old age security and pensions—a challenge to the best minds of the nation. I doubt whether anyone has the final solution to that one.

4. *More scientists should select research problems more closely related to present social problems.* There is no intention here to detract from the many important basic scientific research projects under way. They are necessary even though no immediate applications to industry and every day problems are apparent just now. However, if scientists for a time gave more attention to research that finds immediate social applications, they would surely be performing a greater service to our present society. It may very well mean the difference between the formation of a dictatorship and the preservation of our democracy. So says John Studebaker,[7] United States Commissioner of Education: "We must use our scientific knowledge to benefit the common man by creating a widespread and stable prosperity, or we may lose our democracy, the very mother of science." We must recognize this to be a time of crisis in which extraordinary measures are demanded. As an illustration, recall how during the great war it was necessary for a multitude of our chemists to give up their pet researches for the problems of manufacturing dyes and war gases. Particularly valuable today would be researches leading to new industries or new uses for farm products.

OUR ACADEMY OF SCIENCES AND SOCIAL PROGRESS

Now let us see how an organized group of scientists like the Florida Academy may be a factor working towards social progress.

1. *By encouraging research in social problems*—putting more emphasis on science problems in relation to society. The formation of our Social Sciences Section with this meeting is significant. This should mark the beginning of increased attention to social, economic, and political problems, not alone by the regular workers in the social sciences but also by others.

2. *By concerning itself with the conservation of natural resources.* It is natural and appropriate that the Florida Academy of Sciences should act as guardian of the natural resources of the state. The welfare and happiness of our people depend much on the wise use and the protection of our water, soil, and minerals; on the preservation of our useful and interesting plant and animal life; and on the destruction of harmful

[7] *Vital Speeches,* Vol. 5 (Sept. 15, 1939), p. 727.

organisms. Other state academies of science have already done valuable work in this regard through their special committees on conservation. You will be pleased to know that during this year your Council organized a Conservation Committee with Sidney A. Stubbs, Assistant State Geologist, as chairman. This committee has already acted in regard to the conservation of Florida's artesian water supply, and has by resolutions urging appropriate control measures brought the matter to the attention of the legislators and others vitally concerned. The other members of this committee are R. S. Atwood, H. L. Baker, G. G. Becknell, R. F. Bellamy, A. F. Carr, Jr., Herman Gunter, H. J. Gut, H. H. Hume, Edward T. Keenan, B. M. Kinser, Herman Kurz, H. S. Newins, W. S. Phillips, and G. G. Scott, representing all parts of the state and various phases of conservation. This work on conservation will undoubtedly become increasingly important in Florida. Every member of the Academy should become conservation minded, and should help to create a public interest in conservation, and to give valuable information and suggestions to this committee.

3. *By encouraging and suggesting research.* The Academy can well become a major force toward social progress in Florida if it serves to encourage research in all possible fields. At the first four annual meetings of our Academy the numbers of papers given were respectively 28, 28, 33, and 46. Next year we ought to have at least 60 papers presented. It is safe to say that much of this work would not have been done without the Academy.

There is no better way to get inspiration for one's work and ideas for one's research problems than by attending all the sessions of the Academy. There is a particular value in listening to papers in fields other than one's own—it keeps one from becoming too special—too provincial, if you please. The mathematician can get ideas from the psychologist, the chemist can learn from the biologist, etc. We need more opportunity to look around to see what the other fellow is doing. For this reason we are fortunate in not having too many different sections—some academies have as many as ten or fourteen.

For this very purpose of giving the academy members ideas and suggestions for research problems, your Council brings to you in tomorrow morning's session, Mr. M. C. Forster, Consultant on Research Projects for the Work Projects Administration, from Washington, D. C. Don't miss that special opportunity.

4. *By promoting and encouraging more effective science teaching in our secondary schools and colleges.* The Academy, representing all the sciences, is the logical group to be interested in seeing that our young folks receive the proper instruction in the sciences. As Doctor Allen pointed out this afternoon, and as many of us know, there is

considerable room for improvement in our science teaching in the high schools. To enable the academies to exert a helpful influence in this regard, some of them have instituted sections given over entirely to papers and round-table discussions on science teaching. Then, too, some of the academies have made, and are still making, thorough studies of the status and trend of science instruction in the high schools. The American Association for the Advancement of Science has also acknowledged the need for improvement of teaching of science, and has organized[8] a Committee on the Improvement of Science in General Education. This committee has begun its work by studying the teaching of science in the colleges[9]. Mr. W. L. MacGowan is giving a brief report at this meeting on the formation of a National Committee on Science Teaching by the National Education Association which has thus shown its awareness of the problems in this field.

It is of fundamental importance to the various professions, to industry, and to society how science is taught. We have too many people graduating from high school without having acquired the ability to do elementary scientific thinking. Our Academy should likewise consider both the encouragement of the presentation of many papers on science teaching and the making of a study of the present status and trends in science instruction in the high schools.

5. *By promoting a general interest in science and scientific methods.* Let me read from the constitution of our Academy. "The purposes of the Academy shall be to promote scientific research, to stimulate interest in the sciences, to further the diffusion of scientific knowledge, to unify the scientific interests of the state . . . " The Academy can stimulate general interest by encouraging the widest possible membership—including all high school science teachers and others who have a genuine interest in science. To attract and satisfy this element your Councils have welcomed the presentation of a fair number of papers of general interest, in addition to the more technical papers.

Another important way to stimulate a wide interest in science is through the creation of Junior Academies of Science—composed of the science clubs in the high schools. Eleven of the thirty state academies have already done so. Your Council also has during these past two years worked toward the creation of a Junior Academy. Last year our Vice-President, Miss Charlotte Buckland, did valuable ground work; and this year our Vice-President, W. L. MacGowan, with a great deal of effort, brought the work to fruition. You see by your program that the organization meeting of the Junior Academy of Sciences of Florida is scheduled for tomorrow morning.

[8]*Science,* Vol. 87 (May 20, 1938), p. 454.
[9]*Science,* Vol. 88 (Jan. 13, 1939, p. 34.

Every member of the Academy should be vitally interested in these high school science clubs in his community and should give them every possible assistance and encouragement. It should be remembered that the work is being sponsored by the Academy. It is one of our best methods of furthering the diffusion of scientific knowledge.

To illustrate further the possibilities of promoting a general interest in science, it is well to note what the Kansas Academy of Science is doing. It is undertaking to arouse the layman's interest in the outdoors and the physical world by writing handbooks on the botany, entomology, zoology, archaeology and geology of the state. Florida would offer excellent material in this regard.

6. *By giving proper publicity to scientific matters.* The Academy can let the public know in various ways just what its scientists are doing. Newspaper publicity at the times of the annual meetings usually doesn't do more than give the names of the officers and the general character of the meeting. We need some sort of permanent publicity work active throughout the year. From the material in the third volume of our annual *Proceedings* a skillful writer could make a dozen science news features, highly interesting and informative to the public. The papers in our present program would provide at least twenty feature stories. The intelligent public would like to hear what their nutritionists, entomologists, botanists, geologists, psychologists, and economists have worked out.

Scientists may now be assured of increased interest and cooperation on the part of the newspapers. More and more of them are adding science editors to their staffs. An increasing number of newspaper reporters and writers are devoting their major efforts to the field of science. They have organized a National Association of Science Writers. In their constitution they state their one and only purpose: "To foster the dissemination of accurate scientific knowledge by the press of the nation in cooperation with scientific organizations and individual scientists." Mr. David Dietz, Science Editor of the Scripps-Howard Newspapers, ably described this increased newspaper cooperation in his address [10] to the American Association for the Advancement of Science. He says: "I do not believe that any scientist may feel that he has completed his work when he has finished a piece of research in the laboratory. It is likewise his duty to disseminate the new knowledge which he has uncovered. And today, publication in a journal read by a circle of his colleagues is not sufficient. The welfare of society demands that the general public be made aware of scientific progress. This can be done only through the newspapers, and hence the scientist today must be willing to cooperate with the newspaperman."

[10] *Science*, Vol. 85 (Jan. 29, 1937), pp. 107-112.

7. *Finally,* the Academy may perform an important service to the state by always keeping a close contact with the state legislature on matters in which the scientists can give competent assistance.

In reviewing all these different ways in which scientists may become helpful and significant factors in social progress, one cannot help being impressed with the fact that we have a great responsibility, requiring mature thought and judgment, and determined action. We must cease drifting along. We dare not fail society. The Florida Academy of Sciences has a great work to do!

MASCULINITY-FEMININITY RESPONSES OF FLORIDA STATE COLLEGE FOR WOMEN AND UNIVERSITY OF FLORIDA STUDENTS

Dorothy Rose Disher
Florida State College for Women

The belief that men and women differ in some characteristic way temperamentally as well as physiologically, commonly accepted in the lay mind as well as in song and story, has only recently been subjected to objective analysis. This analysis, developing primarily as a sub-problem in connection with some other major issue, has culminated in the carefully developed Attitude Interest Analysis Test of Lewis M. Terman and Catherine Cox Miles, the main object of which is the discovery and description of sex differences in attitude and interest.[1] While this test, built upon the earlier studies analyzed for sex differences, is the result of ten years of investigation, both extensive and intensive, the authors consider it by no means a finished product. When an instrument of this sort appears it challenges the rest of us to investigate the uses to which it can be put, to discover the strength and weakness of it. This paper reports one step in the study to discover to what extent the test describes our population.

That sex differences in attitude and interests do exist in our present civilization seems to have been clearly demonstrated,[2] although whether the exact extent or nature of these differences has been stated mathematically is open to question. Such sex differences as Mr. Terman and Mrs. Miles report might be a reflection of the population from whose responses the test was constructed and upon which the test was standardized. In short, it is conceivable that Mr. Terman and Mrs. Miles might find differences of some magnitude within a single sex group providing the representatives in the group were reared in strikingly divergent cultures.

An application of the Attitude Interest Analysis Test to diverse populations should throw further light upon the reliability of the description of sex temperament as made by the test.[3] With this in

[1]Terman, L. M. and Miles, C. C., *Sex and Personality* (New York: McGraw-Hill Book Company, Inc., 1936.)

[2]*Ibid.*, p. 472.

[3]Masculinity and femininity are to be interpreted in terms of the sex difference disclosed by the test.

view, the test (Form A) was administered to 556 students at Florida State College for Women during the winter of 1938. The test had not yet been extensively publicized so it is fairly safe to say that we were working with naive subjects. In the late spring of 1939 the test was given to 490 University of Florida students. By that time a number of popular descriptions of the test had appeared in daily newspapers and in popular magazines, so in all probability our masculine population was not entirely naive.

The question at once arises as to why the application of the test to this particular group would be in any way crucial. Our first thought was that these are southern colleges and would therefore reflect the southern tradition, a tradition of sheltered and protected womanhood, of chivalrous gentlemen and great statesmen. Actually 83% of our female population and 73% of our male population were born south of the Mason-Dixon line, 59% and 54% respectively having been born in Florida. In Florida itself there are three cultural influences, to some extent contradictory in nature: (1) in some cases the southern tradition undoubtedly operates, families are proud of their connection with the Old South and endeavor to rear their children in its traditions; (2) there is a large pioneer group which has come to a comfortable climate, perhaps to a region which seems to offer an easier living to a less aggressive people or a more propitious climate to a physically weaker people than a more rigorous climate would; and (3) there is a large, wealthy, pleasure seeking class.

We have the opportunity of comparing such a group with a group consisting of sophomore women and men who were attending Stanford University, Oregon State, Washington State, and the University of Utah for whom Terman and Miles give M-F distributions. Data from these colleges are combined into one distribution. For our purpose it would be desirable to treat these groups separately, although it is likely that there were no outstanding differences in the group M-F responses since this was not done. The Stanford population, at least, must represent both a socio-economic level and an intelligence level different from that of the state universities since it has higher admission requirements. The western state universities, in contrast to Florida State College for Women draw their populations from sections of rigorous winters with industries appropriate to that climate, a country settled by a people who expected to find a hard life as well as a good one.

A final factor must be mentioned. The Florida State College for Women population is entirely female and the University of Florida is almost completely male, whereas the western group is co-educational. Possibly such an environment would tend to make students at Florida State College for Women more introverted, less likely

to exaggerate their emotional or other traditionally feminine reactions. Where such an interesting environmental factor as men is lacking one may have to look inward instead of outward for interests; and where there is no appreciative audience it really does not pay to act. Similarly, the University of Florida is a man's university. Again, the male in the absence of the female does not have to act protective or superior or any one of the dozens of things a man is popularly supposed to be.

Such an analysis of our population together with an analysis of the sex differences revealed by the test provides grounds for a surmise that the northwestern and the southeastern populations might be different in attitudes and interests. The test is made up of seven exercises; two association tests, an information test, a test of emotional and ethical attitudes, one of opinions, and one of introvertive response. In general it may be said, on the basis of the Terman-Miles investigation, that:

> the males included in the standardization groups evinced a distinctive interest in exploit and adventure, in outdoor and physically strenuous occupations, in machinery and tools, in science, physical phenomena, and inventions; and, from rather occasional evidence, in business and commerce. On the other hand the females of our group have evinced a distinctive interest in domestic affairs and in aesthetic objects and occupations; they have distinctively preferred more sedentary and indoor occupations, and occupations more directly ministrative, particularly to the young, the helpless, the distressed. Supporting and supplementing these are the more subjective differences—those in emotion, disposition and direction. The males directly or indirectly manifest the greater self-assertion and aggressiveness; they express more hardihood and fearlessness, and more roughness of manners, language and sentiment. The females express themselves as more compassionate and sympathetic, more timid, more fastidious and aesthetically sensitive, more emotional in general (or at least more expressive of the four emotions considered), more severe moralists, yet admit in themselves more weakness in emotional control, and (less noticeably) in physique.[4]

The southern woman, according to tradition, has centered her life around her home and has left economic and political problems to her husband; whereas the Northern and Western women have been, supposedly, more militant suffragists, demanding release from home duties and a voice in political and economic circles.

Terman and Miles find that as men and women become more educated the M-F differences become less marked, the men becoming more feminine in interests and attitudes and the women becoming more masculine. Possibly high interest in education tends to select

[4]Terman and Miles, *op. cit.*, p. 447.

an intermediate physiological type; surely the educated woman and man are exposed to a broader common environment than are the uneducated. Be that as it may, one might expect to find a less masculine population at the Florida State College for Women and a more masculine population at the University of Florida, since: (1) the students at both colleges come from an environment in which emphasis upon education is of relatively recent origin, (2) in both colleges, classroom examples and applications of learning probably tend to be exclusively in either the feminine or the masculine field of interest, depending upon the sex of the group addressed, and (3) in both institutions there are fewer outside interests—notably in the one case lack of men and in the other lack of women.

The climate might be expected to influence both groups in the direction of femininity.

On the other hand, absence of men or women—little emphasis on the traditional differentiation of the sexes socially—and the pioneer conditions in some parts of the state might tend to produce more masculine men and more masculine women.

Turning now to the analysis of our data, the comparison of Florida and Western distributions reveals two points of difference in both male and female distributions (See Table 1). In both cases the Florida group provides more extremely feminine scores and in both cases the median score for the Florida groups is more feminine, the difference being greater for the male than for the female distributions. These differences in median are very slight, however, when the difference between male and female medians is noted.

TABLE 1

M-F Distribution for Florida and Western[5] Male and Female College Populations

Percentile Score	Male		Female	
	Western	U. of Fla.	Western	F. S. C. W.
100	+200	+187	+ 41	+ 80
95	+139	+140	+ 8	+ 18
90	+125	+124	— 4	— 10
80	+106	+ 99	— 22	— 30
70	+ 95	+ 87	— 40	— 46
60	+ 86	+ 73	— 53	— 60
50	+ 77	+ 59	— 65	— 73
40	+ 66	+ 47	— 76	— 83
30	+ 51	+ 32	— 85	— 96
20	+ 32	+ 17	— 95	—110
10	+ 7	— 3	—107	—126
5	— 17	— 23	—117	—143
0	— 20	—116	—140	—194
N		492		556

[5]*Ibid.*, p. 472.

Study of the various sub-tests in two cases reveals interesting differences between Florida and western populations, particularly in the male distributions. These differences occur in test 1, a word association test, and in test 4, a test of emotional and ethical response (See Table 2.) The Terman-Miles interpretation of test 1 is:

> Females picking more often than the males upon terms for domestic things or happenings, for kindly and sympathetic activities, and for articles or tokens of adornment; males more often than females upon words relating to physical science, machinery, outdoor pursuits, and terms suggestive of excitement and adventure, and rather less predominantly upon political, business, and commercial words.[6]

TABLE 2

FLORIDAN AND WESTERN[7] PERFORMANCES ON TEST 1 AND TEST 4

PERCENTILE SCORE	TEST 1				TEST 4			
	Male		Female		Male		Female	
	West.	Fla.	West.	Fla.	West.	Fla.	West.	Fla.
100		+15		+14		+70		+60
95	+12	+ 8	+ 1	+ 1	+58	+50	+40	+50
90	+10	+ 5	— 2	— 5	+49	+44	+33	+34
80	+ 7	0	— 5	— 9	+40	+35	+25	+26
70	+ 4	— 3	— 8	—11	+34	+32	+19	+17
60	+ 2	— 5	—11	—14	+29	+22	+13	+12
50	0	— 7	—14	—16	+25	+17	+ 6	+ 4
40	— 2	— 9	—16	—18	+20	+12	0	0
30	— 4	—11	—18	—20	+16	+ 6	— 6	— 6
20	— 7	—13	—20	—23	+10	+ 2	—12	—13
10	—10	—17	—22	—26	+ 1	— 8	—20	—24
5	—13	—19	—23	—28	— 8	—14	—26	—34
0		—25		—35		—40		—54

[7] *Ibid.*, p. 476.

In this case the University of Florida population falls about midway between the western male and female groups, and the Florida State College for Women tends to move in the direction of greater femininity. Turning now to test four one finds a similar state of affairs with respect to the male populations. Again borrowing the Terman-Miles description of the sex reaction:

> The female tends much more than the male to extreme expression in all four emotions and in moral censure, particularly in disgust, rather less in pity, less still in fear, and least in anger and censure; though her excess, if less marked for censure than for pity, fear and anger, is more ubiquitous.[8]

On this test also the University of Florida population falls between the western male and female populations.

[6] *Ibid.*, p. 380.
[8] *Ibid.*, p. 415.

On the basis of these last two observations one is tempted to say that our populations are somewhat different from the western populations; that, given more closely defined cultures than those represented at our College or University, one might find greater or other differences. Or, differences disclosed may not be significant since the western distributions were made on the basis of two forms of the test whereas our study is based on Form A.

Accordingly the data were analyzed from another angle; both Florida State College for Women and University of Florida groups were divided into three sub-groups: (1) those subjects born in Florida; (2) those born in the South; and (3) those born in the North. Interestingly enough this classification of subjects serves to separate the distributions further (See Table 3). The subjects who were born in the North, as a whole, rate as masculine as do those of the western group, whereas those born in Florida rank still more feminine than the western group. Not only do our data from the northern group correspond rather closely to the western group, but they also agree, as far as data are given, with a study reported from Minnesota by Gilkinson[9] in which the median score for a group of Minnesota college men was given.

TABLE 3

M-F Distribution of Florida Students Who Were Born in the North and in Florida

Percentile Scores	Male		Female	
	North	Florida	North	Florida
100	+179	+187	+ 80	+ 60
95	+147	+149	+ 25	+ 1
90	+119	+126	+ 11	— 18
80	+ 99	+ 99	— 17	— 32
70	+ 94	+ 84	— 38	— 52
60	+ 86	+ 69	— 51	— 68
50	+ 74	+ 56	— 59	— 79
40	+ 54	+ 43	— 71	— 89
30	+ 47	+ 29	— 78	—102
20	+ 27	+ 14	— 91	—115
10	+ 12	— 5	—100	—133
5	— 5	— 32	—118	—150
0	— 52	—112	—149	—194
N	106	267	71	240

Pursuing the same type of analysis further, the subjects born in the North of pure northern-born parentage were compared with those

[9]Gilkinson, Howard, "Masculine Temperament and Secondary Sex Characteristics: A Study of the Relationship between Psychological and Physical Measures of Masculinity," *Genet. Psychol. Monog.*, Vol. 19 (1937), pp. 105-154.

born in Florida of pure Florida-born parentage. In the case of both men and women this selection of data serves to separate northern and Florida groups still more (See Table 4), the Florida groups, both male and female, tending to greater femininity in attitude and interest.

TABLE 4

M-F Distribution for Florida Students (1) Born in Florida of Florida-Born Parents and (2) Born in the North of Northern-Born Parents

Percentile Score	Male		Female	
	North	Florida	North	Florida
100	+177	+187	+ 75	+ 2
95	+160	+140	+ 25	— 22
90	+144	+ 99	+ 5	— 29
80	+104	+ 81	— 33	— 52
70	+ 96	+ 71	— 40	— 63
60	+ 87	+ 61	— 53	— 72
50	+ 82	+ 50	— 60	— 90
40	+ 72	+ 34	— 73	—100
30	+ 53	+ 21	— 79	—110
20	+ 40	+ 6	— 97	—120
10	+ 19	— 7	—110	—130
5	+ 12	— 32	—130	—142
0	— 52	— 47	—144	—149
N	50	80	44	65

These findings suggest strongly that some selective factor related to regional differences is operating here. The analysis suggests that as groups become more homogeneous within themselves with respect to cultural influences they tend to draw apart from each other in masculinity-femininity response as described by this test. It is possible, however, that this drawing apart of groups is due to some other factor; possibly climate, race, or nutritional influences. This study does not segregate the particular factors but merely suggests that there is either a single factor or a group of factors inclining the Florida population to femininity of response.

In conclusion (1) our results support the Terman-Miles finding that this test describes male and female populations differently; (2) they disclose a greater femininity on the part of Florida born as compared with the northern born; and (3) this greater femininity may reflect different cultural influences or different physiological conditions due to climatic, racial, or nutritional differences.

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A STUDY OF THE DRAGONFLIES OF THE GENUS PROGOMPHUS (GOMPHOIDES) WITH A DESCRIPTION OF A NEW SPECIES[1]

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[1]Contribution from the Department of Biology, University of Florida. The author wishes to express his appreciation to the Museum of Zoology, University of Michigan, for materials and aid in the preparation of this paper. Also, to Drs. Philip P. Calvert and James G. Needham for materials and advice.

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A DISCUSSION OF THE GENUS PROGOMPHUS

Introduction

For the past ten years, the author has been interested sporadically in a study of the species of dragonflies belonging to a genus best known under the name Progomphus. Nearly one hundred years ago, 1842, the first species of the genus, as it is now constituted, was described. Since then twenty-four species have been named and at least two unnamed species are known—one of which is described in this paper.[2] The majority of these species occur in South America and Central America; only three are to be found in North America north of Mexico.

Originally the plan was to write a formal monograph of the genus. However, my experience with the North American species made it conclusive that the genus could not be so treated until adequate series of the South and Central American species were available. Intraspecific variation is such that only after studying large numbers of individuals can a comprehensive picture of the species be obtained.

Rather than delay publication until such a time as series are available, the author has decided to publish his study of the North Amer-

[2]The other unnamed species was described by E. B. Williamson (1920a: 16-17) from Santa Marta but was simply designated as *"Progomphus species"*. In the same paper (1920a: 11), Williamson indicates the probability of other unnamed species.

ican species, where large numbers of individuals are obtainable, with —as a background for future work—some information about the remainder of the genus gathered from literature and a study of the relatively few specimens in the Odonata collection at the University of Michigan (see page 66 for a list of material studied).

The Genus Progomphus Selys 1854

In the Monographie des Gomphines (1858), De Selys presented a comprehensive system for the classification of the Gomphus-like dragonflies. In this work, following his earlier system (Synopsis des Gomphines 1854), De Selys recognized two divisions of the "Subfamily Gomphinae"; one, the "Division of Integrilabiees", with the labium entire; the second, "Division Fissilabiees", with the labium divided by a median cleft.

The grand genus Progomphus was placed in the second legion (Legion II. Gomphoides) of the second subdivision of the integrilabiees. As related grand genera, De Selys listed: Gomphoides (subgenera: Gomphoides, Cyclophylla, Aphylla); Zonophora (subgenera: Zonophora, Diaphlebia); Hagenius (subgenera: Hagenius, Sieboldus). The first legion was reserved for the grand genus Gomphus with fifteen subgenera (most of which are considered good genera today); the third legion included the grand genera Diastatomma and Lindenia, the latter with four subgenera. These three legions constituted the two divisions of the integrilabiees. The fissilabiees included Chlorogomphus, Cordulegaster, Petalia, Petalura, Uropetalia and Phenes.

Williamson (1920b:7) writes, "Since de Selys' Monographie des Gomphines was published our definition of Gomphinae has grown by reduction . . . The Gomphinae of recent authors is the "Division Integrilabiees" of de Selys, containing over fifty genera and three hundred and ninety species."

The dragonflies of the "Division Fissilabiees" have been revised by Fraser (1929). Those of the integrilabiees remain as a group to be revised. However, Williamson (1920b: 6-11) offers a discussion of this complex. On the basis of wing venation, Williamson divides these Gomphines into six series: (1) The *Epigomphus series* to include eight of the genera from De Selys, first legion. (2) The *Progomphus series* to include the grand genera Progomphus and Gomphoides of De Selys and Diaphlebia and Desmogomphus. (3) The *Gomphus series* to include the grand genus Gomphus of De Selys less the Epigomphus series. "It is the dominant gomphine type in the world at the present time." (4) The *Zonophora series* with the single genus Zonophora. (5) The *Hagenius series* to include Hagenius and Sieboldius. (6) The *Diastatomma series*—Legion III of De Selys.

Thus the Progomphus series includes four genera: Progomphus, Gomphoides, Diaphlebia and Desmogomphus. The genus Gomphoides has three distinct subgroups—Gomphoides, Cyclophylla and Aphylla—which may very well be good genera, bringing the number of genera of the series to six. This complex consists of about 60 species, mostly Neotropical, a few of which have penetrated the Nearctic region *(Progomphus obscurus* being the most successful). Williamson (1920b) characterizes the Progomphus series thus: "Genera of this series may be recognized by having the triangles, supratriangles, and subtriangles more or less cross-veined, by dissimilar triangles and subtriangles in fore and hind wings, the triangles of the fore wings being relatively shorter and of the hind wings relatively longer; by the absence of sectors of Rs and M4 and of strongly developed trigonal supplements, and by the outer side of the triangles not distinctly concave." Williamson makes his genus Desmogomphus the most primitive of the series and places the densely veined Gomphoides, such as *G. stigmata,* at the opposite end of the series.

Nomenclature

Nomenclatural difficulties have beset the Progomphus series since the middle of the last century when the genera were being established by De Selys and Hagen (De Selys 1850, 1854, 1858). As regards the genera "Progomphus" and "Gomphoides" these difficulties may be stated as follows:

Under the generic name *Diastatomma,* Rambur (1842) described two American species of the gomphines which he named *D. obscurus* and *D. infumata.* In 1843 under the generic name *Aeshna* there was described the fossil gomphine *A. brodiei* Buckman. In 1850, while working on their famous monographs, Hagen placed *brodiei* in the genus *Gomphus;* De Selys disagreed and said (1850:360 footnote), "I think this belongs to my new American genus *Gomphoides,* the actual type of which is *Diastatomma obscura* Rambur." He thus, according to modern rules of nomenclature, established a valid genus with a designated type. In 1854, evidently forgetting the above quoted note, De Selys reestablished the genus *Gomphoides* with *Diastatomma infumata* Rambur as the type species, at the same time making *D. obscura* Rambur the type of another new genus which he called *Progomphus* (De Selys 1854). This arrangement was carried over to the Monographie des Gomphines (De Selys 1858), the work to which authors are most apt to refer for basic information in this group. The names *Progomphus* and *Gomphoides,* in the Selysian sense, thus became well established in the literature during the following years.

In his Catalogue of North American Odonata, Muttkowski uncovered the above error and corrected it (Muttkowski 1910a:78). By

the code rules (Canon 42 A. O. U. Code and Art. 25 International Code), the name *Progomphus* must be dropped in favor of *Gomphoides* for the genus of which *D. obscurus* Rambur is the type, and the old genus *Gomphoides* with *D. infumata* Rambur as the type must be renamed. This new name was supplied by Muttkowski (1910a, 1910b) as *Negomphoides.*

There is no doubt that the application of the rules of priority make it necessary to discard the name *Progomphus* in favor of *Gomphoides* for the genus under consideration in this paper. If the story ended here, the situation would be relatively simple and easy to handle but it is far more complicated, most of the complications being introduced from the *Negomphoides* side of the case.

Cowley (1934: 244) states the facts as follows:

> Muttkowski has already shown that Selys erected the genus *Gomphoides* so that *Progomphus* Selys became a synonym of *Gomphoides* Selys, since the types of the two genera are congeneric; consequently *Gomphoides* Selys (1854) . . . . required a new name, for which Muttkowski proposed *Negomphoides.* Calvert (1911 [Ent. News 22:81]) and Ris (1912 [Mem. Soc. Ent. Belg., 19:101]) objected to this on the grounds that since the subgenera *Gomphoides, Cyclophylla* and *Aphylla* had now been united, and as according to Art. 28 of the International Rules, "a genus formed by the union of two or more genera or subgenera takes the oldest valid generic or subgeneric name of its components," therefore, since *Gomphoides* was invalid, *Cyclophylla,* which had page preference over *Aphylla* should be used as the name for the genus; as, however, Muttkowski considered *Gomphoides, Cyclophylla* and *Aphylla* as separate genera, he was justified in proposing a new name for *Gomphoides.* Moreover, the exact application of Art. 28 is not clear; Selys used the generic name *Gomphoides* to include his three subgenera; if these subgeneric divisions are united . . ., should the generic name remain the same, or should it be changed to the oldest (valid) subgeneric name? In the former case, the generic name *Negomphoides,* as the new name of *Gomphoides,* must be used; in the latter case, *Negomphoides* cannot be used, since it is not the oldest generic or subgeneric name, therefore the name *Cyclophylla* comes into consideration; but is preoccupied by *Cyclophylla* Brandt (1837) in Coelenterata . . . To propose a new name for *Cyclophylla* Selys would be to repeat the objections against *Negomphoides,* so the oldest valid subgeneric name is *Aphylla.* I believe this confusion may be resolved by applying the second sentence of Art. 28: "If the names are of the same date, that selected by the first reviser shall stand." Calvert (1905 [B. C. A.]) was the first author to unite these three subgenera; he was the first reviser, and "selected" the name *Gomphoides; . . .* then *Negomphoides,* as the new name of *Gomphoides,* must be the valid name of the genus.

To further complicate the matter, Kirby in 1899 described a new species of *Gomphoides* (now *Negomphoides*) which he called *obscura.* There are, therefore, two separate species called *obscura,* both of which have been, or will be, referred to as *Gomphoides obscura.*

The results of these nomenclatural difficulties in the Progomphus series are to make the name Gomphoides so ambiguous and beset by confusion that many authors, priority to the contrary notwithstanding, have returned to the use of the names Progomphus and Gomphoides as employed by De Selys in the Monograph of 1858.

Of some 37 titles published since 1910 involving reference to Rambur's *Diastatomma obscurus* only 7 have employed the generic name *Gomphoides,* the remainder *Progomphus.* Some authors have used both names on different occasions (Byers 1930=*Gomphoides*; 1925, 1927, 1931, 1934a, 1934b=*Progomphus).* Calvert, Williamson, Needham, Ris, Kennedy and others have, to the best of my knowledge, never used *Gomphoides* in place of *Progomphus,* or *Negomphoides* in place of *Gomphoides.* Ris (1911) argues against strict application of priority when it leads to the upsetting of old established names. "Every Odonatologist knows what *Progomphus means;* he will have to look twice to see which *Gomphoides* is meant" (Calvert, in a letter to the author Aug. 17, 1939). Confusion of names has caused one writer (Borror, 1937) to use *Negomphoides* for *Progomphus.* Finally, the rule of priority has been set aside by the International Commission when the strict application of the rule will clearly result in greater confusion than in uniformity (see decision 82. Suspension of Rules for *Musca* Linnaeus). The Gomphoides-Progomphus case so far as I know has never been submitted in this light to the International Commission.

Kennedy (1929: 670), writing on, "The Theory of Nomenclature" says in defense of the rule of priority:

> If some of these names have been excepted from the rule of priority by special rulings of the Commission, such names will always remain sore spots to be reopened by those craving uniform rule. Following a uniform rule of priority will eventually clear the situation as the present literature disappears into the past. Making exceptions will always leave said exceptions for future arguments. We have not removed the emotional from the code by making exceptions to the rule of priority. Elimination of the emotional factors produces stability. The code must be stabilized to become useful. [Kennedy in 1928 was still using the name *Progomphus.*]

The present writer agrees with Dr. Kennedy the rules of priority should be adhered to, but I shall use the name *Progomphus,* until formal monographs for both *Progomphus* and *Gomphoides* may be written and the consequent difficulties ironed-out.[3]

Generic Definition

Genus PROGOMPHUS Selys 1854.
Genus GOMPHOIDES Selys 1850.

[3]A second reason for using *Progomphus* arises from the great amount of quoted material in the present paper.

Type: *Diastatomma obscurus* Rambur 1842.

This genus may be characterized as follows:

Triangle and subtriangle usually[4] with cross-veins (except *P. paucinervis* and *P. gracilis.*) Supratriangle usually free of cross-veins.

Triangles and subtriangles of fore and hind wings dissimilar, triangle with outer side somewhat angulate, (4 sided).

Stigma with proximal base-vein.

Arculus at or proximal to 2nd Anq[5]; sectors of arculus distinctly separated at their origin by an interval greater than the thickness of either sector.

Usually one submedian cross-vein (Cuq) present (usually two in the fore wing of *P. phyllochromas*).

Usually one basal subcostal cross-vein (Scq) present (except *P. gracilis, P. auriopictus* and *P. lepidus).*

Thickened distal Anq usually the fifth.

Trigonal supplement well developed.

1-2 rows of cells between M1 and the next supplementary sector below at the level of the distal end of the stigma.

2 rows of cells between M1 and M2 beginning more remote than half-way from nodus to stigma.

2 rows of postanal cells in fore wing beginning proximal to the level of the triangle (except *P. pygmaeus, P. gracilis* and *P. paucinervis.)*

3 or more rows of cells between Cu2 and the hind wing margin.

Anal loop absent or indistinct.

Anal triangle of males not reaching backward to the anal angle of the wing; usually three celled.

Legs short, hind femora hardly reaching to the apex of the first abdominal segment, with short spines all of about equal length.

An occipital ridge present between the compound eyes.

Inferior appendages of the male bifid, the arms not divergent.

[4]"Usually" as here employed means "to be expected"; that the wing feature thus designated is present in at least one of the wings (either fore or hind or both as stated) but may be absent or modified in the other or others; generally it is present in all of the wings indicated, (see analysis of wing venation for *P. obscurus* page 42.) "Except" means that the feature thus described is usually lacking, but it may be present in a small percentage of cases, seldom in all wings of the same specimen.

[5]I am using the cross-vein abbreviations employed by Ris (1908, 1911, 1916):
Anq=antenodal cross-vein.
Pnq=postnodal cross-vein.
Scq=basal subcostal cross-vein.
Cuq=submedian cross-vein (other than the ones forming parts of the triangle).

The Species of the Genus Progomphus

The genus *Progomphus* is limited in its geographic distribution to the Western Hemisphere and at present consists of 26 species including the unnamed form described by Williamson (1920a:16-17).

These species may be listed as follows, in order of the date of description.

1. *Progomphus obscurus* Rambur. Described in 1842, the first species of the genus to be described and probably today the best known. Type locality given by Rambur—North America. (Rambur 1842).

2. *Progomphus gracilis* Hagen. 1854. Brazil (De Selys 1854).

3. *Progomphus complicatus* Selys. 1854. Brazil, Bahia (De Selys 1854).

4. *Progomphus costalis* Hagen. 1854. Brazil (De Selys 1854).

5. *Progomphus zonatus* Hagen. 1854. Mexico (De Selys 1854).

6. *Progomphus intricatus* Hagen. 1858. "The Amazon Country" (De Selys 1858).

7. *Progomphus paucinervis* Selys. 1873. Quito [Ecuador] (De Selys 1873).

8. *Progomphus borealis* MacLachlan. 1873. Oregon [United States] (De Selys 1873).

9. *Progomphus pygmaeus* Selys. 1873. Bogota [Colombia] (De Selys 1873 appendix).

10. *Progomphus integer* Hagen. 1878. Cuba (De Selys 1878).

11. *Progomphus serenus* Hagen. 1878. Haiti (De Selys 1878).

12. *Progomphus polygonus* Selys. 1879. Merida [Venezuela] (De Selys 1879).

13. *Progomphus clendoni* Calvert. 1905. Mexico (Calvert 1901-1908 B. C. A.)

14. *Progomphus joergenseni* Ris. 1908. Argentina. (Ris 1908).

15. *Progomphus recticarinatus* Calvert. 1909. Brazil (Calvert 1909).

16. *Progomphus auriopictus* Ris. 1911. "Territory Misiones" [Argentina]. (Ris 1911).

17. *Progomphus lepidus* Ris 1911. "Territory Misiones" [Argentina] (Ris 1911).

18. *Progomphus recurvatus* Ris 1911. "Espirito Santo" [Brazil] (Ris 1911).

19. *Progomphus basistictus* Ris. 1911. "Territory Misiones" [Argentina]. (Ris 1911).

20. *Progomphus longistigma* Ris. 1916. Costa Rica. (Ris 1916).

21. *Progomphus phyllochromus* Ris. 1916. Peru. (Ris 1916).

22. *Progomphus perpusillus* Ris. 1916. Peru. (Ris 1916).

23. *Progomphus risi* Williamson. 1920. Guatemala. (Williamson 1920a).

24. *Progomphus sp.* 1920. Guatemala. The described but unnamed species of Williamson. (Williamson 1920a).

25. *Progomphus dorsopallidus* Byers. Venezuela. (Byers 1934b).

26. *Progomphus alachuensis* n. sp. Florida [United States].

In general the type localities of the above listed species may be grouped as follows: Brazil 6; Argentina 4; United States 3; Peru, Venezuela, Guatemala, and Mexico each 2; Colombia, Ecuador, Costa Rica, Haiti and Cuba each 1.

Thus the genus is primarily a South American group with the greatest number of species occuring apparently in Brazil. The nymphs of Progomphus are associated ecologically with moving water and clean sand bottom habitats. No doubt the many small tributaries of the Amazon furnish ideal habitats for them.

Key to the Dragonflies of the Genus Progomphus

The following key has been compiled chiefly from published descriptions (see literature references for each species as given in the foregoing list of species) and has been checked against the available study material (see list of material studied page 66). Specimen identification should be checked with drawings of the male appendages and of the thoracic pattern (Plates III, IV and V) when available.

1—No basal Scq present ..... (2)
—Basal Scq present ..... (4)

2—A diffuse golden yellow spot under the stigma of both wings; generally 2 Cuq in fore wing; a light line on front of dorsal suture; superior appendages of males small and acute; inferior appendages with no evident side branches; stigma light reddish brown, 3 mm. long, covering 5 cells; abdomen of male 29 mm, hind wing 24 mm. ..... *auriopictus.*
—No yellow apical spot on wing; 1 Cuq in fore wing; dark lateral portion of thoracic pattern well developed; no light line on dorsal suture; superior appendages of male longer than 10th abdominal segment; inferiors with side branches forked ..... (3)

3—Male with pale humeral stripe broad, connected with collar, upper portion wedge-shaped and tapering; female with humeral stripes well separated from collar, reduced to narrow short lines; male superior appendages very much expanded at base, abruptly narrowed at center with a small angle on lateral margin; branches of inferior appendages very slim, dorsal branch distinct from ventral view; stigma dark reddish brown, 3 mm. long, covering 4-5 cells; abdomen 27-28 mm. long; hind wings 22-24 mm. long ..... *gracilis.*

—Male with pale humeral stripes narrow, sides parallel, united at lateral edges to very reduced collar, (female unknown); male superior appendages parallel, lateral basal expansions very indistinct; branches of inferior appendages thick, branches of dorsal process small, not noticeable when viewed ventrally; stigma grey-brown. ..... *lepidus.*

4—Dark brown markings present at base or along costa of wings ..... (5)

—No dark markings present on wings; colors, if present, limited to ochre, yellow or grey. ..... (15).

5—Wings with brown costal band from base to apex, limited by R and M1; size large, abdomen 34-36 mm., hind wing 27-31 mm. ..... *costalis.*

—Wings with no such wide costal brown band. ..... (6)

6—Stigma light yellow; no tubercle on the venter of abdominal segment 1..... (7)

—Stigma dark brown to black; tubercle usually present on venter of abdominal segment 1. ..... (8)

7—Face brownish with a distinct black band; brown spot on nodus; size large, abdomen 37 mm., hind wing 28 mm. ..... *joergenseni*

—Face greenish grey, no distinct dark stripes or bands; no brown nodal spot; size medium, abdomen 32 mm., hind wing 23 mm. ..... *dorsopallidus.*

8—Face with distinct brown markings ..... (9)

—Face with diffuse or no brown markings. ..... (11).

9—Lower lip burnt yellow; upper lip deep brown, with the sides surrounding a large oval milk-white spot, anterior border narrowly brown; rhinarium white; nasus deep brown with lateral round spot and border next to rhinarium white; frons deep brown ahead, white above, the base in front of ocelli with broad band of deep brown; stigma 4 mm. long surmounting 7 cells. ..... *integer.*

—Face lacking white markings ..... (10).

10—Face with dark markings on inferior part of frons, on middle of nasus, and middle of labrum; pale humeral stripe not confluent with the green or yellow of the anterior mesothoracic margin; pale metepisternal stripe almost interrupted to form a superior spot and an inferior stripe; wings with the slightest trace of brown at extreme base, not reaching half-way to Scq; stigma 4.5 mm. long, surmounting 9 cells; abdomen 40-43 mm., hind wing 32-33 mm. long. ..... *zonatus.*

—Face with lower lip indistinctly yellowish-brown, upper lip light olive, lower part of frons olive, upper part diffuse brown; top of head dark brown; pale humeral stripe similar to *zonatus;* pale metepisternal stripe entire, not interrupted or broken; wings with very dark blackish-brown patches at the base extending nearly to Anq 1; stigma 3.5 mm. long; abdomen 32 mm., hind wing 25 mm. long. ..... *basistictus.*

11—Face with obscure brownish markings on inferior part of frons, on middle of nasus and middle of upper lip; pale humeral stripe not or barely (i e., by a line) confluent with the green or yellow of the anterior mesothoracic margin; pale metepisternal stripe similar to *zonatus;* abdomen 38-41 mm., hind wing 29-31 mm. long. Female unknown ..... *clendoni.*

—Face without brown markings; pale humeral stripe broadly or very narrowly confluent with the yellow-green of the mesothoracic margin (collar);

pale colors predominating on the mesepimeron and metapleuron, pale stripes thereon not interrupted; wings with two short basal brown stripes.....(12)

12—A single row of denticles on the inferior margin of male superior appendages, the carina extending to the last denticle .....(13)

—Denticulated carina on the inferior margin of male superior appendages terminating apically in two or more rows of denticles, the carina not extending to the last denticle. .....(14)

13—Brown basal stripe in costal and subcostal spaces not reaching beyond basal subcostal cross-vein; no brown traces at origin of sectors of arculus; pale humeral stripe very broad and broadly joined to the pale area of the mesothoracic collar; male superior appendages yellow; size large, abdomen 41-47 mm., hind wing 31-38 mm. long. .....*borealis.*

—Brown basal stripe in costal and subcostal spaces reaching to first antenodal cross-vein or nearly so; a trace of brown between sectors of arculus at their origin; pale humeral stripe narrow, sides serrated, not or very narrowly joined to the restricted pale area of mesothoracic collar; male superior appendages with tips yellow, basal third brown; size: abdomen 34-39 mm., hind wings 30-35 mm. long. .....*alachuensis,* n. sp.

14—Brown basal stripe of the costal and subcostal spaces reaching to first antenodal cross-vein or nearly so; a trace of brown between the sectors of the arculus at their origin; pale humeral stripe narrow, sides straight, joined to pale area of mesothoracic collar; male superior appendages yellow; size: abdomen 35-41 mm., hind wing 30-37 mm. long.....*obscurus.*

15—Size small; abdomen, male 18-25 mm., female 19-28 mm. long; hind wing, male 15-22 mm. long. .....(16)

—Size larger; abdomen, male 29-39 mm., female 30-40 mm. long; hind wing, male 24-34 mm., female 25-36 mm. long. .....(19)

16—Size very small, male abdomen 18 mm., hind wing 21 mm. Female unknown. .....*perpusillus.*

—Size larger, abdomen 22-28 mm., hind wing 19-25 mm. long. .....(17)

17—Stigma dark-brown, 4-4.5 mm. long; thorax dark, pale humeral stripe broadly wedged shape, tips attenuated, sides dark; abdomen 28 mm., hind wing 22-25 mm. long .....*longistigma.*

—Stigma dark-brown; thoracic pattern not as above. .....(18)

18—Anal field of fore wing one-cell wide throughout; 3 cells in proximal row of postanal cells in hind wing; legs, especially third pair, relatively long and slender; hind tarsus without claws, about two-thirds as long as hind tibia; occipital hairs long (35-40 mm.); thoracic pattern distinct [Pl. IV fig. 1] .....*pygmaeus.*

—Anal field of fore wing two-cells wide for short distance both distal and proximal to the level of the triangle; 4 cells in proximal row of postanal cells in hind wings; legs, especially third pair, short and stubby; hind tarsus without claws, longer than the shortened second tibia, giving the leg a malformed appearance; occipital hairs short (.25 mm); thoracic pattern distinct [Pl. IV fig. 8]. .....*risi.*

19—Stigma yellow or gray-brown. .....(20)

—Stigma dark brown, red or black. .....(21)

20—2 Cuq in fore wings, 1-2 in hind wings; thorax with mesepisternal light

band (pale antehumeral stripe) lacking; pale humeral stripe very broad, yellow. ..... *phyllochromus*

—Usually 1 Cuq in all wings; thorax with pale antehumeral stripe present; pale humeral stripe narrow and angulate at mesothoracic collar....*recurvatus.*

21—Triangles of wing nearly always free; fore wing with the anal field proximal to the triangle one-cell deep; stigma 3 mm. long covering 5 cells, clear brown; wings clear; face yellow with appearance of black on the frons; abdomen 31 mm., hind wing 29 mm. long. .....*paucinervis.*

—Triangles 2-3 celled, seldom any free; fore wing with anal field proximal to triangle with at least a few double cells.....(22)

22—Pnq 11-14; face light olive or white-green.....(23)

—Pnq 7-10; face dark brown or if light having dark bands.....(24)

23—Triangle of fore wing with usually three cells; Anq. 15, Pnq 11-12; face white-green, sides pale green .....*serenus.*

—Triangle of fore wing with usually 2 cells; Anq. 16-17, Pnq 13-14; face olive green slightly reddish. .....*polygonus.*

24—Size small, abdomen 30 mm., hind wing 25 mm.; all triangles 2 celled; Anq. 10-14, Pnq 7-8; stigma 4-5 mm. long; face, labium, nasus and frons rich dark brown. .....[Williamson's unnamed species. 1920a]

—Size larger, abdomen 30-39 mm., hind wing 23-36 mm., Anq 12-17, Pnq 8-10. .....(25)

25—Face blackish-brown; size larger, abdomen 36-39 mm., hind wing 28-36 mm. long. .....*complicatus.*

—No blackish-brown on face; size smaller, abdomen 30-36 mm., hind wing 23-30 mm.; yellow predominant on dorsum of abdominal segments 3-7. ....(26)

26—Occiput wide; superior frontal band pale brown; hindlobe of prothorax blackish; dark color of thorax pale brown; distance on fore wing from nodus to stigma 6-7 mm. .....*intricatus*

—Occiput narrow; superior frontal band blackish; hind lobe of prothorax yellow; dark color of thorax blackish-brown; distance on fore wing from nodus to stigma 7-8 mm. .....*recticarinatus.*

SPECIES OF PROGOMPHUS OCCURRING IN NORTH AMERICA NORTH OF MEXICO

It has been noted that *Progomphus* is primarily a South American genus with the greatest number of its species occurring apparently in Brazil; also, that there have been described two species from North America north of Mexico—*P. obscurus* Rambur 1842 and *P. borealis* MacLachlan 1873. The writer is describing a third species *P. alachuensis* in this paper.

Historical Survey

The two described North American species of *Progomphus* have received a variety of treatment at the hands of various taxonomists. *P. borealis* has been considered a good and distinct species by some, a synonym of *P. obscurus* by others and a subspecies of *P. obscurus* by still others. The history runs somewhat as follows:

1842. Rambur described *obscurus,* from North America, under the generic name *Diastatomma.*

1850. De Selys made Ramur's *obscurus* the type of the genus *Gomphoides* (see discussion page 22.)

1854. De Selys wrote a description of adult female of *P. obscurus* and stated, "Male unknown. Habitat: North America (Coll. Selys and Berlin Museum)." In this same paper, De Selys erected the genus *Progomphus* with Rambur's *obscurus* as the type.

1858. In the Monographie des Gomphines, De Selys repeated the description and notes from the Synopsis (1854 above) and adds, "Habitat North America after the female specimen in which the body is nearly destroyed, and which served as a type for M. Rambur and which is to be found in the Serville Collection coming from that of Latreille. The other specimen is in the Museum of Vienna, and its origin is not known." Some notes are included on the resemblance of *P. obscurus* to other species of *Progomplus* and related genera.

1861. Hagen, under the name *P. obscurus,* rewrote the material from De Selys 1858 and noted, "Habitat: North America (Vienna Museum; collection of de Selys Longchamps)."

1872. Cabot assigned a nymph collected near Wareham, Massachusetts to *P. obscurus* on supposition.

1873. De Selys, in the 3rd addition to the Synopsis of the Gomphines, included a description of a male gomphine under the name *Progomphus borealis* MacLachlan, stated that the female was unknown, and wrote, "Habitat: Oregon. One male from Lord Walsingham. (Communicated by M. MacLachlan) . . N. B. Differs from *P. costalis* (of Brazil) by larger size . . . . it approaches *obscurus* and *zonatus* in size. It is easily separated from the first by the absence of an obscure mark at the origin of the sectors of the arculus, the stigma more abrupt not surmounting 5 cells, and the costa yellow externally."

To this point in the chronology, except for the unfortunate generic mix-up made by De Selys in 1850 and 1854, events have taken place smoothly enough. There have been described two species of North American *Progomphus—obscurus* and *borealis.* The former represented by two female specimens, one in the Museum of Vienna, the other in De Selys' hands, both specimens recorded simply from North America by both De Selys and Hagen; the latter species represented by a single male from Oregon, the specimen apparently in the hands of MacLachlan. The nymph has been described from Massachusetts by Cabot. The next year, however, Hagen published a paper that greatly complicated the situation.

1874. Hagen described a male *Progomphus* from an adult specimen and "Abbott's drawings" in the British Museum, the specimen

having been taken in Georgia. He assigned the name *Progomphus borealis* MacLachlan to this specimen and wrote (1874: 356), "The discovery of this genus, hitherto not represented in the fauna of North America, is very interesting." This statement is hard to explain in view of the De Selys (1858) and Hagen (1861) records of female *Progomphus obscurus* "Habitat: North America." Yet, that Hagen was saying what he wanted to say is indicated by a statement in the introduction to this same (1874) paper, "I was able directly to recognize [from drawings of wing venation] a genus which I had never seen from North America before, and of which only a short time ago a species was described from Oregon by Baron de Selys Longchamps. As I have had the pleasure since to receive from Mr. Uhler a specimen from Georgia, the verification of this interesting drawing was confirmed." [page 350]. Thinking that the specimen and drawing that he had was *P. borealis,* perhaps what Hagen *wanted* to say was: The discovery of this *species* (not genus) from *eastern* North America is very interesting. He continued his discussion under *P. borealis* [page 356] as follows, "The only male described by de Selys is from Oregon, and I have not seen it, but the description agrees; nevertheless, as the specific differences in *Progomphus* species are rather obscure, and as the two localities, Oregon and Georgia, are very distant, perhaps the species from the latter State may prove distinct." Why Hagen did not think to compare his Georgia material with *P. obscurus* is hard to say unless he associated *P. obscurus* with the *Progomphus* fauna of Mexico and Central America; thus leaving "North America" in this paper to represent a more circumscribed area than in his 1861 publication. Hagen continues his discussion, "All that I can say now, is that I am unable to find differences between *P. borealis* and Abbott's species. It is worthy of notice, that Mr. Cabot in his monograph of the immature state of the Gomphina, p. 6 [Cabot 1872] has described nymphae from Wareham, Mass., supposed to belong to a species of *Progomphus*." Dr. Hagen follows these remarks with a complete description of a male *Progomphus* from Georgia, the specimen being "in Mr. J. Ridings collection." This description indicates that this specimen was *P. obscurus.* In Hagen's mind, at this date, therefore, there was only one species of *Progomphus* in North America north of Mexico, namely *P. borealis* from Oregon and Georgia with the possibility of larvae from Massachusetts.

The next year, in his *Synopsis of the Odonata of America,* Hagen listed (1875: 48) both *Progomphus obscurus* and *Progomphus borealis.* Under the former he said. "Hab.: North America. A female from Boston, Mass., July; may belong to *P. obscurus*." However under *P. borealis* he wrote, "Hab.: Oregon; Georgia; Dallas, Texas. I have seen

two males from Georgia and Texas and the figures of male and female by Abbott." Note that the specimens that Hagen has seen have all been from the east, i. e., within the range of *P. obscurus* as we know it today (Dallas is on the western boundary of this range). Hagen continued, "MacLachlan states that the two small teeth before the tip of the superior appendage are present . . there is no further doubt about the identity [synonymy] of the males from Oregon and Georgia."

In 1878, when De Selys issued his 4th addition to the Synopsis of the Gomphines, he stated that, "Hagen has written to me recommending that *borealis* be made identical with *obscurus* of Rambur. After a detailed examination of the material in my collection (type with head and abdomen missing), I am tempted to believe that the two species named should be united. At the time M. MacLachlan described *borealis* we had in front of us only two specimens of young males, in each of which the brown mark of the origin of the sectors of the arculus was not distinct. However, we now have full adults in which this condition varies." De Selys includes a description of a female in this paper and gives the habitat of the species *P. obscurus* (synonym *P. borealis*) as Georgia, Dallas (Texas), Boston and Oregon. So at this date we still have only one species of *Progomphus* north of Mexico but its name is now *P. obscurus—P. borealis* has been relegated to synonymy. When and how Hagen "discovered" *P. obscurus* is not in the literature.

The tendency of writers after 1878 was to accept De Selys' judgment and to refer to all specimens of *Progomphus* taken north of Mexico as *P. obscurus*. However, in the following years *P. borealis* gradually worked back into the literature as a good species. It is of significance to note that in all probability Hagen and perhaps also De Selys, never saw a specimen of the real *P. borealis* until circa 1880.

In 1885, Hagen discussed the nymphs of *Progomphus* in his paper on the immature form of the Odonata. In his work he includes the diagnostic characters of the *Progomphus* nymph, a description of the nymph of *P. obscurus* from Wareham, Mass., and notes on two other *Progomphus* nymphs designated as Nos. 31 and 32 with no species name attached. Of the *P. obscurus* material he says, "As *P. obscurus* has now been collected near Boston, by Mr. Morrison, there can scarcely be a doubt that the nymphae belong to this species." It is his note under "32. *Progomphus* species" that is of special interest, "Six nymphae in alcohol young and some probably full grown from Santiago, Cala., ... Length 20-27 mm., breadth 7 mm. These nymphae are so similar to *P. obscurus* that it is difficult to separate them: but all have lateral spines on segments 3 to 9 instead of 5 to 9. The black spots above the abdomen are larger; the ventral segments 6-10 have transversal black bands, enlarged to the lateral margins; the abdomen

a little broader. Perhaps the nymphae belong to *P. zonatus* or to *P. meridionalis* n. sp. from Arizona, as a similar nymph 24 mm. long was collected by R. Crotch, San Diego, Cala.'

The nymphs that Hagen described above (1885, No. 32) are undoubtedly those of *P. borealis* for he has included in his description most of the special characters of *borealis* as worked out by Kennedy (1917b). Also his remark that, "Perhaps these nymphae belong to *P. meridionalis* n. sp., from Arizona" indicates that Hagen, on encountering his first specimen of *P. borealis* thought it was a new species and named it *P. meridionalis*. Hagen never published a description of *P. meridionalis*. However, Calvert (1901 B. C. A.) says, "I doubt whether Hagen recognized the true *borealis,* especially since he labelled the above listed material [of *P. borealis* as determined by Calvert] from Arizona in the M. C. Z. *meridionalis*."

The next few years saw no important changes in this situation. However, in 1905, Calvert, dealing with the genus in the Biologia Centrali Americana, wrote, "Although Selys and Hagen, in their latest paper, regarded *obscurus* and *borealis* as identical, I have ventured to separate them again, the differential characters drawn from the carina of the male superior appendages being herewith presented for the first time." Dr. Calvert continued with the remarks regarding *P. meridionalis* quoted above and gave diagnostic descriptions of both *obscurus* and *borealis*. However, in separating these two species, Calvert went only part way; he made subspecies—*Progomphus obscurus obscurus* and *Progomphus obscurus borealis*.

In 1910, Muttkowski, *Catalogue of the Odonata of North America*, follows Calvert and lists *borealis* as a subspecies of *obscurus*. During these years however, authors generally followed De Selys and spoke of *Progomphus obscurus* as the only member of the genus in North America north of Mexico; however, Williamson (1914) used *P. borealis* for the western form.

C. H. Kennedy (1917b), writing on the Dragonflies of California and Nevada, stated, "I believe the Pacific coast form (of *P. obscurus*) to be a distinct species, so it would have to be called *Progomphus borealis* MacLachlan. It differs in the imago in being larger than *obscurus* and in having a single row of denticles on the inferior side of the male superior appendage. In *obscurus,* as pointed out by Calvert, the posterior end of this row is double or treble." Dr. Kennedy goes on to show that, "The differences between the two species are more conspicuous in the nymph than in the adult."

Williamson (1920a), in listing the described species of *Progomphus* says, "The elevation of *borealis* to its proper specific rank makes the number twelve . . . . "

Most of the authors writing between 1905-1929 were dealing with the eastern species and so used *P. obscurus* correctly as a species name. Kennedy (1921) used *P. borealis*, Seeman (1927) used *P. obscurus* in referring to the western species.

In 1929, Needham and Haywood placed *P. borealis,* once again, as a synonym of *P. obscurus* but added in a footnote, "Perhaps the west coast *G. borealis* [sic] of MacLachlan should rank as a distinct species. Kennedy thought so and gave some good reasons." From this date on authors dealing with the western species have used the name that they prefer.

A curious departure in naming arose when Munchberg (1932) used the name *P. dorsalis* to refer to *P. borealis.* Where the name came from I do not know.

The present writer, after working for some time on the taxonomic characters of the various species of *Progomphus,* the results of which are contained in this paper, has reached the same conclusion that Kennedy (1917b) and Williamson (1920a) arrived at, namely that *P. borealis* and *P. obscurus* are two separate and distinct species and should be regarded as such. Furthermore, the foregoing historical survey makes it apparent that these two species would never have been synonymized if it had not been for the unfortunate misconceptions of Hagen (1874, 1875, 1885) and the dearth of material in the hands of De Selys (1878).

Geographic Distribution

The distribution of the three species of *Progomphus* occurring in North America north of Mexico, with limiting-dates of capture, are given below; adult and nymphal records have not been separately indicated. The data have been derived from two sources, (1) literature—reference to which is given after each set of state records, (2) material studied for the preparation of this paper, including records from material in the Museum of Zoology, University of Michigan, not studied in detail by the author—see material studied (page 66) for these records. There is some overlapping of data as derived from these sources, as much of the material in the Michigan collection has been previously published on; also, as authors tend to pass records from one to another, year following year, through the literature.

Progomphus obscurus.—The eastern North American species. Distributed from central Florida north along the Atlantic seaboard to the region of Boston, Mass., west through northern Michigan to Iowa and Kansas, south to eastern Texas; on the wing from February (in Florida) to August. Detailed distributional data as follows:

Florida.—Alachua, Jackson, Liberty Cos.—Feb. 2-July 12. *Lit.*

ref.: Byers (1930, 1934a); Needham (1897) this record is in all probability one for *P. alachuensis* n. sp.; Calvert (1901) after Needham.

GEORGIA.—Johnson, Wayne Cos., June. *Lit. ref*: Hagen (1874), "A specimen from Mr. Uhler" under name *P. borealis;* De Selys (1878) after Hagen; Calvert (1901) after Hagen; Byers (1931); Kennedy (1917a).

ALABAMA.—Mobile Co. (Naveco),—February (nymphs). *Lit. ref.*: Wright (1939).

LOUISIANA.—Covington (Bogue Chitto River, Sulphur Springs), Pollock (Big Creek).—March-July (nymphs). *Lit. ref.*: Wright (1939).

NORTH CAROLINA.—Walnut Creek, Pool's Bridge, Lake Ellis, Southern Pines, Pine Bluff, Fuquay Springs—May-July. *Lit. ref.*: Brimley (1903, 1908, 1918, 1938): Calvert (1901) after Brimley. Brimley (1938) gives the distribution as, "Raleigh, Southern Pines and eastward."

TENNESSEE.—Jellico (Cumberland River), Parker's Lake.—June-July. *Lit. ref.*: Wilson (1912): Wright (1938) after Wilson.

KENTUCKY.—Livingston, Walthersville (Powell Co.), Pineville (Straight Creek), Parker's Lake—July-August. *Lit. ref.:* Williamson (1905); Calvert (1901) after Williamson; Garman, H. (1924).

NEW YORK.—Wading River, Deep Pond—June-August. *Lit. ref.*: Needham (1901) says, "The genus *Progomphus* has not been found in New York state, but it will probably be eventually. It ranges from Massachusetts southward and westward across the continent, a single *P. obscurus* Seyls [sic], having been taken in the whole of northeastern United States."; Davis (1913); Needham (1926) after Davis.

NEW JERSEY.—Lakehurst, Brown's Mills, Bamber—May-July. *Lit. ref.*: Calvert (1910); Davis (1913); Montgomery (1933). Calvert (1923) states (in relation to this species), ". . . of limited occurrence in New Jersey."

NEW ENGLAND.—*P. obscurus* is apparently distributed along the Atlantic seaboard in New York and New Jersey (no records for inland New York State) and reaches its northern limit around Boston, the records from the Boston area being the only ones for this species from the whole of New England. For the New England area, Howe (1917) records, "Very rare—June 5 to Aug. 9."; Garman, P. (1927), "New England—June 5-Aug. 9."; Howe (1921) includes *P. obscurus* as part of the "Cape Fauna" and says, "The following thirteen typically southern species [including *P. obscurus*] occur only along the coast as far as Provincetown, and rarely Cape Ann;" for *obscurus* he adds "Transcontinental, summer,—largely confined to the outwash ponds of the Cape."

MASSACHUSETTS.—Boston, Wareham, Chatham—South Orleans—June-July. *Lit. ref.*: Hagen (1875, 1885); Calvert (1901, 1905); Howe

Howe notes, "South Orleans . . . Recorded only from Boston and Wareham before, this being the third station in New England."

PENNSYLVANIA.—Allegheny Co., Ohio Pyle—May-June. *Lit. ref.*: Williamson (1899, 1902); Calvert (1901) after Williamson. *Note*: These records are from the southwestern part of the state not far from the Ohio line. *P. obscurus* has not been recorded from central or eastern Pennsylvania.

OHIO.—Gallia Co. (Vinton), Lawrence Co. (Ironton)—May 12-August 11. *Lit. ref.*: Hine (1900, 1913); Williamson (1899); Calvert (1901); Borror (1935, 1937). *Notes*: These records are from the lower south-east tip of Ohio near the West Virginia-Kentucky line. The literature records seem to be all based on the early work of Hine.

INDIANA.—Allen, Cass, Dearborn, Elkhart, Gibson, Huntington, Jasper, Kosciusko, Lagrange, Miami, Noble, Parke, Posey, Putnam, Steuben, Warren, Wells, Whitley Cos.—June 2-August 26. *Lit. ref.*: Williamson (1899, 1901, 1917, 1920c); Kennedy (1902, 1928); Needham and Hart (1901); Calvert (1901); Montgomery (1925: Pts. 1, 3, 4, 7, 8, 9). *Note:* These counties are well distributed over the state and some of them have been intensively worked (Wells Co. for example).

MICHIGAN.—Cheboygan, Emmet, Lake, Washtenaw—June 28-August 1. *Lit. ref.*: O'Brien (1911); Evans (1915); Byers (1925, 1927). *Note:* The Douglas Lake records (Cheboygan and Emmet Cos.) represent the farthest point north that *P. obscurus* has been taken.

WISCONSIN.—No records. Muttkowski (1908) predicts its occurrence in the southern part of the state.

ILLINOIS.—Effingham (Little Wabash River), Spoon River—June-July. *Lit. ref.*: Hagen (1885); Williamson (1899); Needham and Hart (1901); Calvert (1901). Needham and Hart state, "The nymph of this species . . . . has not been found in the Illinois or its adjacent lakes, but seems common in the sand of the smaller rivers, such as the Spoon River and upper Sangamon . . . . The adults are rare in collections although the species seems widely distributed. The adult has been taken in Illinois June 29 to July 13."

IOWA.—Henry Co. Hoffman (1924).

MISSOURI.—Carter, Stoddard (Dexter Cos.)—June-July. *Lit. ref.*: Williamson (1932).

ARKANSAS.—Lincoln Co.—July. No literature references.

KANSAS.—Clark, Hamilton, Harper, Logan, Ness, Osborne, Rooks, Russell, Trego Cos.—June-July. *Lit. ref.*: Calvert (1901); Kennedy (1917a). Kennedy writes, "Eastern species which cross Kansas and reach their western limit somewhere on the plains of eastern Colorado." Again in the same paper he says, "An eastern species, found only on

streams whose beds are loose, flowing sand, in which its highly specialized nymph burrows. All the Kansas records except Harper county (south central) are from the western end of the state, where sandy streams abound."

Oklahoma.—Alfalfa, Beckham, Canadian, Cleveland, Comanche, Cotton, Greer, Hughes, Kiowa, Latimer, Love, Major, Oklahoma, Pontotoc, Pushmataha, Tillman, Woods Cos. *lit. ref.*: Bird (1932).

Texas.—Dallas, Victoria (Colleto Creek.)—July. *Lit. ref.*: Hagen (1875); De Selys (1878); Calvert (1901); Kennedy (1921). Kennedy remarks, "It is interesting to those studying distribution to find that these *obscurus* naiads from Texas, where both *obscurus* and *borealis* are found, are in no wise intermediate in character between the two species but are true *obscurus* naiads." *Note*: The above locations are in eastern Texas.

Progomphus borealis.—The western North American species. Distributed from northwestern Mexico and Baja (Lower) California north to Oregon and east to Colorado, New Mexico and western Texas; on the wing from April to October. Detailed distributional data as follows:

Texas.—Presidio Co. (Shafters, Marfa), Jeff Davis Co. (Phantom Lake)—June-September. *Lit. ref.*: Kennedy (1921); Tinkham (1934). *Note*: These two counties are in the extreme southwestern corner of Texas.

New Mexico.—Albuquerque.—April 18, 1903 (a teneral female specimen in University of Michigan collection).

Colorado.—No definite record for *P. borealis*. A. D. Hess, in a Master's Thesis from Colorado College, 1933, writing on the "Dragonflies of the Pikes Peak Region" records *P. obscurus* from the "Foothill Zone, 5,800-8,000 feet." From the locality this is probably *P. borealis*, though Kennedy (1917a) states that the true *P. obscurus* reaches its western limit ". . . somewhere on the plains of eastern Colorado."

Utah.—Washington Co. (St. George)—June 6, 1919. *Lit. ref.*: Brown (1934).

Arizona.—Catalina Mts. (Pima Co.); Granite Reef Dam, Mesa, Salt River, Gila Bend (Maricopa Co.); Hot Springs, Jerome, Prescott (Yavapai Co.); Florence (Pinal Co.); Ft. Grant, Graham Mts. (Graham Co.); Bright Angel, Colorado Canyon—April-September. *Lit. ref.*: Currie (1903); Calvert (1901); Williamson (1914); Tinkham (1934).

California.—Los Angeles, Santiago, Santa Ana River, Palm Springs, Chico, Oroville, San Jose—June. *Lit. ref.*: Calvert (1895, 1901); Kennedy (1917b); Seeman (1927); Needham and Heywood (1929).

Oregon.—The type locality for the species. *Lit. ref.*: MacLachlan (De Selys 1873); Hagen (1874, 1875) after De Selys; Calvert (1895, 1901) after De Selys. As nearly as I can determine, no specimen of *P. borealis* has recorded from Oregon since MacLachlan's type was sent by Lord Walsingham (De Selys 1873).

Mexico.—Baja California (Purissima); Sonora (Hermosillo); Chihuahua (Santa Rosalia); Jalisco (Guadalajara); Michoacan (Uruapan)—April-October. *Lit. ref.*: Calvert (1895, 1901); Williamson and Williamson (1930).

Progomphus alachuensis, n. sp.—The Florida species. Distribution restricted to central Florida; on the wing from February to May.

Florida.—Clay, Alachua, Orange, Volusia, Lake Cos.—Feb.-May. *Lit. ref.*: (under name *P. obscurus*) Byers (1930 in part); Davis and Fluno (1938); Needham (1897), in all probability Needham's specimen from Orange Co. is of this species.

Overlapping Regions.

Florida.—The ranges of *P. obscurus* and *P. alachuensis* overlap in Florida. In Alachua County—the northern extent for *alachuensis* and the southern for *obscurus*—both species are part of the fauna, *alachuensis* occupying the lakes and *obscurus* the cooler streams (see discussion page 56). It is also possible that *P. integer,* from Cuba, may turn up some time in the southern part of the state.

Texas.—The ranges of *P. obscurus* and *P. borealis* meet in Texas (Kennedy 1921) and, in all probability, in Colorado also (Kennedy 1917a). *Progomphus* has been reported from the latter state but which species the writer is not certain.

Mexico.—Mexico has a sizable *Progomphus* fauna in addition to *P. borealis* which has been reported as far south as Uruapan. The ranges of *P. zonotus* and *P. clendoni* overlap that of *P. borealis* along its southern limit. *P. pygmaeus* and *P. risi* occur farther south (Guatemala).

Flying Season.

A study of the foregoing records indicates that the flying season of the North American *Progomphus* varies considerably. Over most of the territory, these dragonflies may be considered as part of the summer fauna—June to early August with the peak in mid-July. However, in Florida both *P. obscurus* and *P. alachuensis* are spring species —February to June (occasionally July) with the peak in May. Farther north (Georgia and Carolinas) the season apparently moves forward somewhat—May to July with the peak in June. On the other hand, *P. borealis* may emerge as early as April (Mexico, New Mexico, Arizona) and remain on the wing as late as September (Arizona) or even October (Mexico), thus becoming part of the autumn fauna in the southwest.

PROGOMPHUS OBSCURUS (Rambur) 1842

SYNONYMY. The following authors have used the following names in referring to this species:

Diastatomma obscura Rambur.—Rambur (1842).

Gomphoides obscura (Rambur)—Brimley (1938); Byers (1930); Cowley (1934); Davis (1913); Hine (1913); Muttkowski (1910a); Wilson (1912); Selys (1850).

Progomphus obscurus (Rambur)—Bird (1932); Borror (1935); Brimley (1903, 1908, 1918); Beutenmuller (1890); Byers (1925, 1927, 1931, 1934a, 1934b); Butler (1904); Cabot (1872); Calvert (1901, 1905, 1910, 1923); Evans (1915); Garman, H. (1924); Garman, P. (1927); Hagen (1861, 1875, 1885); Hine (1900); Hoffman (1924); Howe (1917, 1919, 1920, 1921); Karsch (1890); Kennedy (1902, 1917a, 1917b, 1921, 1928); Kirby (1890); Lew (1934); Montgomery (1925, 1933); Muttkowski (1908); Needham (1901, 1903a, 1903b, 1926); Needham and Hart (1901); Needham and Anthony (1903); Needham and Heywood (1929); O'Brien (1911); Ris (1908, 1911); Selys (1854, 1858, 1878 pars); Williamson (1899, 1901, 1902, 1905, 1917, 1920c, 1932); Wright (1938, 1939); St. Quentin (1938).

Progomphus obscurus Selys.—Needham (1901).

Progomphus obscurus obscurus (Rambur).—Calvert (1901).

Progomphus borealis MacLachlan.—Hagen (1874, 1875).

Negomphoides obscura Rambur.—Borror (1937).

DESCRIPTIONS. Satisfactory descriptions have been written by the following authors:

De Selys (1858: 202-205). Gives earliest detailed description, female only.

Hagen (1874: 356-358). Complete description of male, from Georgia specimen and Abbott's drawings, under name of *P. borealis*.

Williamson (1899: 283). Brief description of male and female.

Calvert (1901: 148-149). Presents diagnostic and "key" characters, some of them new.

P. Garman (1927: 126-127). Compact description.

Needham and Heywood (1929: 62-63). Brief description, key characters and notes (drawings are of *P. borealis*).

Byers (1930: 48-50). Description of male, female and nymph.

Figures—The following have published figures of this species:

Wings: P. Garman, (1927: Pl. X, fig. 1); Needham (1903a: Pl. 34, fig. 2).

Head: Williamson (1899: Pl. IV, figs. 3-4).

General: Needham and Anthony (1903: Thorax); Butler (1904: labium); Lew (1934: head); St. Quentin (1938: legs); Kennedy (1917a: Pl. I, fig. 14-18), have made morphological studies of the Odonata including this group.

Diagnostic Characters

Head (fig 1. Pl. I).—Top of frons semi-angular with a median indentation, 3.8-4.0 mm. in length; hind margin of occiput concave, depth moderate.

Thorax (fig. 3. Pl. III).—Pale humeral stripe broad, joined to the pale area of the mesotharacic collar, edges straight and parallel, dorsal area between dark and medium brown (not light). Pale antehumeral stripe variable (see discussion p. 43) usually present as a fine, but distinct, stripe separated from the pale spot above the antealar carina.

Abdomen.—Obscure reddish-brown. Paler dorsal pattern on segments 3-7 reduced and not conspicuous. Segments 8-10 usually solid brown, occasionally with pale yellow wash along sides; no distinct yellow spots or bands. No tubercle present on the venter of segment 1; a median spine present in the males. Vulvar lamina of females (fig. 1. Pl. II) with a V-shaped central notch.

Appendages male (fig. 4. Pl. II).—Superior abdominal appendages short (2-2.5 mm.) blade-like, lower margin curving to the tips in lateral view (fig. 4. Pl. I), inferior margin with two or more rows of denticles apically, the carina not extending to the last denticle; color bright yellow. Inferior appendages black, comparatively short and heavy.

Wings.—Brown basal stripe of costal and subcostal spaces reaching to the first antenodal cross-vein or nearly so; usually a trace of brown between the sectors of the arculus at their origin (may be absent in a small number of specimens—usually western ones). Stigma reddish-brown, 4 mm. long in males, 5 mm. long in females. For variation in wing venation see analysis given below.

Size.—Medium large, abdomen 36-38 mm., hind wings 31-34 mm.

Variation

A study of variation, based on the material examined (see page 66), gave the following results:

Wing venation.—Venation, based on 128 ♂ fore and hind wings and 12 ♀ fore and hind wings (64 ♂ and 12 ♀ specimens) varied as follows:

TABLE 1

Cross Veins

	Number		Average	
	♂	♀	♂	♀
Anq of fore wings	13-19	15-18	15.30	16.62
Anq of hind wings	5-14	11-15	11.45	12.13
Pnq of fore wings	6-12	9-13	9.49	10.42
Pnq of hind wings	7-13	9-13	9.91	10.62
Scq in all wings	1 except left fore wing and right and left hind wing of one male which had none.			
Cuq in all wings	1 except 6 ♂ fore wings, 2 ♂ hind wings, 1 ♀ hind wing in all of which 2 were present.			
Distal thickened Anq	2nd in 1 wing 3rd in 2 wings 4th in 8 wings		5th in 255 wings 6th in 37 wings 7th in 1 wing	

TABLE 2

Cells

	♂		♀		Same in Both			
	Fore-wing	Hind-wing	Fore-wing	Hind-wing	Fore wings		Hind wings	
Triangle:								
1 celled	0	0	0	0				
2 celled	0	98	1	11			43 ♂	5 ♀
3 celled	126	27	23	12	62 ♂	11 ♀	6 ♂	4 ♀
4 celled	1	3	0	1				
Subtriangles:								
1 celled	1	28	0	2			8 ♂	1 ♀
2 celled	124	98	23	18	60 ♂	11 ♀	42 ♂	7 ♀
3 celled	2	2	1	4				
Supra-triangle:								
1 celled	127	123	24	22	63 ♂	12 ♀	61 ♂	11 ♀
2 celled	0	5	0	2			2 ♂	1 ♀

Stigma covers cells: Male fore wing 4-8 (aver. 5.99); hind wing 4-8 (aver. 6.01). Female fore wing 6-9 (aver. 7.09); hind wing 5-9 (aver. 6.99).

Anal field of fore wing proximal to the triangle 2 cells wide for a distance of from 4-6 cells (average approximately 5), these may be so irregularly arranged as to make counting difficult.

Anal triangle of male: 2 celled in 1 wing; 3 celled in 108 wings; 4 celled in 19 wings.

Measurements[6] (in millimeters).—Abdomen (including appendages) male 35-41 (aver. 36.92); female 35-41 (aver. 38.77). Length

[6]Montgomery (1933) collected four males near Brown's Mills, N. J. of which he states, "These specimens which measure 46, 47, 47, and 48 mm. in length, are considerably smaller than other specimens of this species which I have seen."

of hind wing male 30-33 (aver. 31.38); female 32-37 (aver. 34.28). Stigma length male 4-5 (aver. 4.15); female 5-5.5 (aver. 5.04).

Variation in Geographic Groups.—For the purpose of studying regional variation within the species, the above data and the specimens upon which they were based were broken down into three geographic groups:

Group 1=Florida, Georgia, Alabama	(25 specimens)
Group 2=Kentucky, Indiana, Michigan	(10 specimens)
Group 3=Arkansas, Missouri	(41 specimens)

In general, there were no constant differences between groups sufficiently marked to warrant geographic races. However, certain tendencies were noted:

Group 1. The only group in which triangles of 4 cells appear. Also, the group in which the anal triangle of the male is most apt to show the 4-celled condition.

Groups 1 and 2. Have somewhat smaller bodies, larger wings and, in general, darker color than group 3. These features are more marked in group 1 than in group 2.

Group 3. The western specimens are paler brown than the eastern; the brown dorsal area on the thorax between the pale humeral stripes markedly so. In this group there is a strong tendency for the subtriangle of the hind wing to be open (1 cell—no cross-veins). On the whole, the western specimens have larger bodies and slightly smaller wings than have the eastern ones.

Variation of the Thoracic Pattern.—Within *P. obscurus,* there is a marked and graded variation in the degree of development of the dorsal thoracic pattern (pale humeral and antehumeral stripes and the surrounding dark areas).[7]

This graded variation is most noticeable in observing the pale antehumeral stripe throughout the series. The behavior of this stripe may be likened to the development of a photographic negative—at first the plate is uniform and then slowly the picture appears, the high-lights first. The series studied thus may be arranged, on the basis of the antehumeral stripe, into an arbitary set of six grades as follows:

Grade 1. Pale antehumeral stripe absent; pale antealar spots faintly indicated (fig. 2. Pl. III).

Grade 2. Pale antehumeral stripes present but very faint; pale antealar spots present, separated from antehumeral stripe.

[7]Also, this holds true when a series of specimens of *P. borealis* and *P. alachuensis* are studied along with *P. obscurus.*

Grade 3. Pale antehumeral stripe present, thin, distinct, separated from pale antealar spots (fig. 4. Pl. III).
Grade 4. Pale antehumeral stripe present, fairly wide, distinct, approaching union with the pale antealar spots.
Grade 5. Pale antehumeral stripe wide (0.5 mm.), distinctly joined with the pale antealar spots (fig. 3. Pl. III).
Grade 6. Pale antehumeral stripe quite wide (0.7 mm.), broadly joined with the pale antealer spots (fig. 5. Pl. III).

The following table (including *P. alachuensis, P. borealis* and the three geographic groups of *P. obscurus* given above), based on the six pattern grades, shows the amount and nature of this antehumeral variation:

TABLE 3

ANTEHUMERAL VARIATION

SPECIES	NO. OF SPECIMENS	GRADES					
		1	2	3	4	5	6
P. alachuensis	27	24	3	0	0	0	0
P. obscurus—group 1	25	3	6	11	5	0	0
P. obscurus—group 2	10	0	0	6	1	3	0
P. obscurus—group 3	41	0	3	31	3	4	0
P. borealis	12	0	0	0	0	0	12
Total all	115	27	12	48	9	7	12
Total P. obscurus	76	3	9	48	9	7	0

The remainder of the thoracic pattern, while showing some variation, is not as definite as the above. There is a gradual tendency, already noted, for the colors to become lighter from southeast to west and for the humeral stripe to become broader and more distinctly joined to the pale area of the mesothoracic collar.

ECOLOGICAL NOTES:—Information on the habits, frequency and special peculiarities of *P. obscurus* may be gathered from a reading of published material covering various portions of the species' range.

Brimley (1903: North Carolina) states, "Fairly common in summer in sunny spots along the banks of Walnut Creek usually resting, when not in flight, on bare patches of sand or mud close to the water's edge . . . . This species was also observed at Poole's bridge . . . . resting, when not on the wing, on bare rocks projecting above the surface of the water."

Byers (1925: Michigan) writes, "Common along sandy beaches of Douglas and Burt Lakes." However, for Florida, Byers (1930) notes, "Very little is known of the adult habits of this species in Florida. Certainly it is a very shy, retiring, woods-loving form. In spite of the very common occurrence of the nymphs, only four adults have appeared in collections examined." I may add that, at the present date, more Florida material is available (see material studied

p. 66); also, that the adults are not so rare if looked for at the right time and place—central Florida lake shores in May.

Davis (1913: New Jersey) states, "Found on several occasions in May and June flying up and down a shaded ditch by the side of the railroad track at Lakehurst, N. J." Needham and Heywood (1929) reprint Prof. Davis' observation. Montgomery (1933), also collecting in New Jersey, reports specimens from, "Along a stream in the pine barrens near Brown's Mills."

Howe (1919: Massachusetts) writes, "Not uncommon in oak scrub Mr. Bangs tells me."; again (1917), in the Manual of the Odonata of New England, he notes, "Very rare—scrub oak uplands, rivers and lakes"; later in the Manual, Howe adds "ponds" to the foregoing statement.

Kennedy (1917a: Kansas) notes, "*Progomphus obscurus* occurs wherever in the east there are sand bedded streams, as its nymph is adapted to rapid burrowing in flowing sand; consequently it is abundant throughout western Kansas."; again in the same paper, "An eastern species, found only on streams whose beds are loose flowing sand . . . ."

Both Williamson and Montgomery have recorded observations of *P. obscurus* in Indiana. Williamson (1899) states, "Not rare at the ripples [St. Mary's River, Ft. Wayne?], a pair taken resting on a boulder in mid-stream." In later years, Williamson (1920c) writes of an interesting case as follows, "Salamonie River, Huntington Co., ... several caught and others seen, many had wings darkly stained with crude oil; Wabash River, Bluffton, Wells Co. . . . . only one seen, a male with oil stained wings. At this time there was no crude oil along the Wabash River near Bluffton, and I think the Wabash specimen was undoubtedly a stray from the Salamonie about twenty miles away." Montgomery (1925: Pt. 1) writes, "A teneral female [taken near Vincennes] was resting on the tip of a dead weed a few feet from a gravel pit in the manner of *Celethemis elisa.*" Again, (1925: Pt. 3) Montgomery quotes Williamson (unpublished), "A male taken along stream south of Goshen . . . . Stream 12-20 feet wide, swift and deep. Several seen, resting on logs in stream. This individual flew along stream and lighted on vertical twig in a dead cornus bush—only time I ever saw *obscurus* on a twig."

Wilson (1912: Tennessee) states, "This species was very common on the Clear Fork of the Cumberland River at Jellico . . . . a dozen of each sex were obtained. . . . . Both sexes rest much of the time upon the sand of the river bank in bright sunshine. They are easy to approach and capture at such times and are not as swift flyers as many of the gomphines." The present writer's experience in collecting

P. obscurus in Wayne and Johnson Cos., Georgia tends to confirm Wilson's observations in Tennessee.

Williamson (1932: Missouri) notes, "*Progomphus* sat on twigs, weed stems, and, preferably, flat on sand bars [stream west of Dexter, Stoddard Co.]".

One adult habit, that I have noticed in both *P. obscurus* and *P. alachuensis,* has not been mentioned by any of the foregoing authors. That is, when the adult is at rest, with the feet on a flat surface, the body assumes a position in which the thorax and abdomen are tilted away from the plane of the resting surface at a marked angle (45-60°) making the insect appear as if it were standing on its head. Calvert (1901) and Williamson (1914) have observed this habit in *P. borealis.*

In regard to the habits of *P. obscurus* it may be deduced from the above material that:

1) The species, over most of its range, is not rare and may frequently occur in numbers large enough to deserve "not uncommon."

2) It is most intimately associated with sand bottomed streams, lakes or even pools where its larva may find burrowing conditions.

3). It usually rests on some low projecting object (rock, etc.), or simply on the ground close to the water's edge; but may, on occasion, alight on twigs, low bushes, etc. When resting on the ground it assumes the characteristic tilted position.

4) The species tends to be associated with woods (oak scrub, pine barrens, hammocks) where it flies in the shade or rests in open sunny spots near water.

5) It is shy, but not a fast flier or unusually difficult to capture.

Progomphus borealis MacLachlan 1873

Synonymy. The following authors have used the following names in referring to this species:

Gomphoides borealis (McLachlan).—Muttkowski (1910a); Needham and Heywood (1929: foot-note).

Progomphus borealis (MacLachlan). — Brown (1934); Byers (1934b); Hagen (1875); Kennedy (1917b, 1921); Selys (1873-MacLachlan); Williamson (1914, 1920a); Williamson and Williamson (1930).

Progomphus obscurus (Rambur).—Calvert (1895); Currie (1903); Kirby (1890); Needham and Heywood (1929); Selys (1878); Seeman (1927); Tinkham (1934).

Progomphus obscurus borealis MacLachlan.—Calvert (1901).

Progomphus dorsalis.—Munchberg (1932).

Progomphus meridionalis [Nomen nudum of Hagen].—Hagen (1885); Calvert (1901).

Progomphus No. 32.—Hagen (1885).

Descriptions. Satisfactory descriptions have been written by the following authors:

De Selys (1873: 764-765). The original description of the male sent to De Selys by MacLachlan.

De Selys (1878: 471). Description of female (in part) and note on synonymy.

Calvert (1895: 499-502). Detailed description of male and female.

Calvert (1901: 148-149). Presents diagnostic and "key" characters.

Kennedy (1917b: 524-529). Good description.

Figures—The following have published figures of this species:

Calvert (1895: Pl. XVI, figs. 74-79). Male genitalia (3 figs.), female vulva, triangle and adjacent parts of right fore wing.

Kennedy (1917b: figs. 148-154, page 524). Color pattern, segments nine and ten of female, segment two of male, segment ten and appendages of male (3 figs.).

Needham and Heywood (1929: page 63). Male genitalia, female vulva (under name *P. obscurus;* same figures published by Byers—1930); also, (page 58), drawing of the basal area of hind wing (reprinted from Seeman—1927).

Diagnostic Characters

Head (fig. 2. Pl. I).—Top of frons angular, 4.2 mm. in length; hind margin of occiput straight with slight median convexity, thick.

Thorax. (fig. 5. Pl. III). Pale humeral stripe very broad, joined broadly to the pale area of the mesothoracic collar, edges straight and parallel, dorsal area between light in color. Pale antehumeral stripe narrow, distinct, joined with the pale spot above the antealar carina.

Abdomen.—Segments 3-7 black with dorsal yellow area composed of a broad basal spot narrowly connected with a more rounded apical spot which does not reach the apical margin. Segment 8 black with two basal cuneiform yellow spots on dorsum; sides with a yellow spot near apical margin. Segment 9 dorsum black, two lateral yellow spots—one basal (which may be lacking) the other apical. Segment 10 black with a yellow spot below the base of each superior abdominal appendage (♂), or with entire apical half or more yellow (♀).[8] No tubercule present on venter of segment 1; a median spine present in males. Vulvar lamina (fig. 2. Pl. II) with a broad U-shaped central notch.

[8]In one female specimen examined, all of segment 10 was yellow except for a reduced black median basal line.

Appendages male (fig. 5. Pl. II).—Superior abdominal appendages long (3 mm.), ends truncate in lateral view (fig. 5. Pl. I), a single row of denticles on the inferior margin, the carina extending to the last denticle; color bright yellow.

Wings.—Brown basal stripe in costal and subcostal space reduced, not reaching beyond the basal subcostal (Scq) cross-vein; no trace of brown at the origin of the sectors of the arculus (may also be absent in a small percentage of specimens of *P. obscurus).* Stigma black, 4 mm. long in males, 5-5.5 mm. long in females. Wings in general with dense venation (see venation analysis below).

Size.—Large (average length of abdomen 44 mm.), proportions slender. In general, *P. borealis* is a large, slender, pale colored *Progomphus.*

Variation

A study of variation in wing venation and measurements, based on the material examined (see page 66), gave the following results. The tables are based on the study of 18 ♂ fore and hind wings and 6 ♀ fore and hind wings (9 ♂ and 3 ♀ specimens).

TABLE 4
Cross Veins

	Number		Average	
	♂	♀	♂	♀
Anq of fore wings	14-17	15-18	14.88	16.83
Anq of hind wings	10-12	11-15	10.88	12.16
Pnq of fore wings	7-10	8-11	8.70	9.60
Pnq of hind wings	8-11	8-12	9.83	9.05
Scq in all wings	1 in all counted except the left fore wing of 1 ♀ in which 2 were present.			
Cuq in all wings	1 in all counted except the right fore wing of 1 ♂ in which 2 were present.			
Distal thickened Anq:	4th in 2 wings; 5th in 42 wings; 6th in 4 wings.			

TABLE 5
Cells

	♂		♀		Same in Both			
	Fore wing	Hind wing	Fore wing	Hind wing	Fore wings		Hind wings	
Triangle:								
1 celled (open)	0	0	0	0				
2 celled	0	5	0	0			2 ♂	
3 celled	18	13	2	4	9 ♂	1 ♀	6 ♂	2 ♀
4 celled	0	0	4	1		2 ♀		
5 celled	0	0	0	1				
Subtriangle								
1 celled	0	6	0	0			2 ♂	
2 celled	17	12	1	6	8 ♂		5 ♂	3 ♀
3 celled	1	0	5	0		2 ♀		
Supratriangle								
1 celled	18	17	6	6	9 ♂	3 ♀	8 ♂	3 ♀
2 celled	0	1	0	0				

Stigma covers cells: Male fore wing 4-7 (aver. 5.50); hind wing 5-6 (aver. 5.61). Female fore wing 6-8 (aver. 6.75); hind wing 5-8 (aver. 5.83).

Anal field of fore wing proximal to the triangle 2 cells wide for a distance of from 5-7 cells (approximate average 5), these may be so irregularly arranged as to make counting difficult.

Anal triangle of male: 3 cells in 16 wings; 4 cells in 2 wings.

Measurements (in millimeters).—Abdomen (including appendages) male 41-47 (aver. 44.18); female 42-47 (aver. 44.00). Length of hind wing, male 31-35 (aver. 32.88); female 35-38 (aver. 36.00). Length of stigma male 4 (aver. 4.00); female 5-5.5 (aver. 5.16).

Ecological notes.—Information on the habits, frequency and special peculiarities of *P. borealis* may be gathered from a reading of published material covering various portions of the species' range.

Probably *P. borealis* has been most thoroughly observed in California. Writing on the habits of the adult in this State, Kennedy (1917b) says:

> This western *Progomphus* is apparently widely distributed throughout California, but during the summer's collecting I have seen not more than ten or twelve specimens on the wing. Perhaps the expression "widely distributed" should be used with some qualification as under it I have included the evidence from the wide distribution of the nymphs . . . . Apparently this species has a long season on the wing as Grinnell's records are from May to August. On the Chico River the few individuals I saw were flying about a quiet pool at the head of a long rapids and when not in motion were seated on snags in the water or on the gravelly shore. Their habits seem much like *Ophiogomphus bison* with which they were associated, except that they were much more wary and difficult to capture. Their large size, slender abdomen and peculiar brown thorax readily distinguish them in the field from any other western gomphine.

In this same paper, Kennedy records *P. borealis* from "An elevation of 2,500 feet", he also repeats (p. 541) observing it in association with *Ophiogomphus bison* but adds *Gomphus sobrinus,* and (p. 605) notes again that it is difficult to capture.

Needham (Needham and Heywood, 1929), writes, "In May the adults were seen along the upper reaches of the Santa Margarita River [California]. . . . They flew swiftly from one resting place on the bare sand to another and were very inconspicuous when at rest. They were not especially difficult to approach by stalking, or to capture when at rest." Writing from this same region, Seeman (1927) records, "The adult is usually seen flying about the borders of streams. It may be most easily captured by clapping a net down

over it as it rests on the sand; but one must look closely, for it is a clear winged creature and inconspicuous when quiet, although it is easily recognized when caught. . . ."

Tinkham (1934) in writing of this species (he uses the name *P. obscurus*) in southwestern Texas states, "The Cibolo creek at Shafter supported *Progomphus obscurus* as its commonest species. . . . There were no adults in the air at this time in late May." To a locality record in southern Arizona (10 miles east of Gila Bend), Tinkham, in this same paper, appends, "Very rare and miles from any water." Williamson (1914) writing about September Dragonflies About Mesa Arizona, says in regard to *P. borealis*, "All were taken away from water 10-40 feet; were resting on the tips of twigs, often with the abdomen elevated, and none were seen resting on the ground." Currie (1903) records one male of *P. borealis* as having been taken in July at Bright Angel, Colorado Canyon, Arizona, at an elevation of 2,700 feet.

Notes on *P. borealis* in Mexico are sparse. Calvert (1901) writes, "This species and *Erpetogomphus crotalinus* were found on sand, or mud-banks, hardly above water-level, along the sides of an irrigation ditch into which water from the baths of Santa Rosalia empties. On alighting on these banks, *P. obscurus borealis* held its abdomen slanting upward to form an angle of 45-60° with the bank, while *E. crotalinus* held it nearly horizontal." In addition to the above, Williamson and Williamson (1930) mention *P. borealis* as an associate, "along this stream [Rio Purissima], of a new Mexican species—*Erpetogomphus natrix*.

Progomphus alachuensis, n. sp.

Synonymy. The following authors have applied the name *Progomphus obscurus* or *Gomphoides obscurus* to this species.

Gomphoides obscurus (Rambur).—Byers (1930, in part): Davis and Fluno (1938).

Progomphus obscurus (Rambur).—Byers (1934a, in part); Needham (1897, probably).

Description

Holotype Male. Rear of head deep brown above to tan below; two light tan spots at outer margin of compound eyes. Face and mouthparts pale greenish-yellow to buff; mandibles, base of labrum and front of frons deeper brown. No distinct stripes, bands or spots on face. Frons above long (4.5 mm.) and narrow (fig. 3, Pl. I), light greenish yellow with a median posterior, ill defined oval, darker brown area. Compound eyes dark brown. Vertex and antennae chiefly dark brown,

lighter toward inner angles of compound eyes; postocellary ridge present as a double tubercle behind lateral ocelli. Occiput yellow, deeply furrowed at base between projecting angles of compound eyes, hind margin straight, edged with fine hairs (fig. 3 Pl. I).

Prothorax dark brown, a large pale irregular spot on lateral margins of dorsal plate; sides light brown to tan.

Thorax (synthorax) predominantly dark brown, especially on the dorsum; colors ranging from dark brown to greenish-yellow and gray. Thoracic pattern (fig. 2. Pl. III) as follows: mesothoracic collar yellow, divided at mid-dorsal carina which is edged with yellow. Pale thoracic (humeral) stripe narrowly separated from pale area of mesothoracic collar; narrow with jagged edges and tapering ends, color yellow. Pale antehumeral stripe absent, represented by a faint spot near the antealar carina. Mesepimeral stripe pale, complete, about 1 mm. wide; remainder of mesepimeron dark brown. Metepisternum brown becoming lighter near the second lateral suture. Metepimeron pale greenish-yellow except for a brown stripe along the second lateral suture. Mesinfraepisternum golden brown, lighter near base of coxae. Metinfraepisternum light greenish yellow with brown sutures.

Legs dark to light brown with coxae and knees yellow; front femora light yellow below, next pair darker, hind femora dark brown below.

Wings clear with a brown basal stripe in costal and subcostal areas reaching as far as the first antenodal cross-vein or nearly so; a trace of brown between the sectors of the arculus at their origin; anal crossing (Cuq) slightly infuscated. Costa yellow; remaining veins dark brown. Stigma light yellow-brown, 5 mm. long, covering 6-7 cells. Antenodal cross-veins (Anq) of fore wing 15-16; hind wing 10-11. Distal thickened antenodal the fifth. Postnodal cross-veins (Pnq) of fore wing 8-9; hind wing 9-10. A single basal antenodal cross-vein of the second series (Scq) present in all four wings. Anal field of fore wing proximal to the triangle two cells wide for a distance of five cells. Anal triangle with three cells. Supratriangle open—no cross-veins. Cells of triangle (T) and subtriangle (Ti) vary in the four wings as follows:

$$T = \frac{3:3}{2:2} \quad Ti = \frac{2:2}{2:0}$$

Abdomen, in general, black to brown on sides, yellow markings on dorsum which become obscure in dried specimens. Segments 1-2, sides pale green to yellow, dorsum brownish with large pale area on segment 2; auricles yellow. Segments 3-7, sides black to dark brown, dorsum with a broad basal yellow area narrowly joined to a more reduced subapical yellow spot. Segment 8, sides golden brown, dorsum somewhat darker, no distinct pattern. Segments 9-10, practically

uniform dark brown, no yellow spots. Venter of segment 1 with a small median basal spine; no ventral tubercle. Accessory genitalia or second abdominal segment 2 (fig. 7. Pl. I) yellow to dark brown.

Superior abdominal appendages (fig. 6. Pl. I) long (2.8 mm.), slender and pointed; a single row of denticles on inferior margin (fig. 6. Pl. II) carina extending to the last denticle; tips light yellow, basal third brown. Inferior appendages and accessories (fig. 6. Pl. II) dark brown to black.

Measurements: Total length 55 mm. Abdomen, including appendages, 40 mm. Fore-wing 34 mm. Hind wing 32 mm.

Material: Holotype male. Alachua Co., Florida. Newnan's Lake (4 miles east of Gainesville). May 18, 1930. Catalogue No. 17; specimen No. 15. C. F. Byers collection.

Allotype Female. Similar in most respects to the male; head pattern essentially the same. Top of frons oval, 5 mm. long; hind margin of occiput straight. Thoracic pattern the same; pale humeral stripe narrowly joined to the pale area of the mesothoracic collar. Legs similar to male.

Wings colored as in male; an additional reduced brown stripe in cubital area not reaching to the anal crossing (Cuq), an extra cross-vein in this area of the left hind wing. Stigma 6 mm. long, covering 7-8 cells. Antenodal cross-veins (Anq) of fore wing 17; hind wing 13-14. Distal thickened antenodal the sixth. Postnodal cross-veins (Pnq) of fore wing 8-9; hind wing 9-11. A single antenodal cross-vein of the second series (Scq) present in right fore and hind wing, lacking in left fore and hind wing. Anal field of fore wing proximal to the triangle with double cells irregularly arranged. Supratriangle open—no cross-veins. Cells of triangle (T) and subtriangle (Ti) in the four wings as follows:

$$T = \frac{3:3}{2:2} \qquad Ti = \frac{2:2}{2:2}$$

Abdomen more robust than in male. Color pattern essentially similar. Basal pale area and subapical spot on dorsum of segments 3-7 larger, covering more of the top of the segments. Lateral apical corner of segment 9 with reduced yellow spot; dorsum of segment 9 and all of segment 10 dark brown. Appendages conical, 1.5 mm. long—slightly longer than the dorsum of segment 10, base brown, tips yellow. Vulvar lamina (fig. 3. Pl. II) with deep U-shaped notch, sides of notch parallel.

Measurements: Total length 54 mm. Abdomen, including appendages, 39 mm. Fore wing 36 mm. Hind wing 35 mm.

Material: Allotype female. Alachua Co., Florida. Newnan's Lake. May 18, 1930. Catalogue No. 17; specimen No. 19. C. F. Byers collection.

Paratypes. From the material examined the following are designated as paratypes. All are from Florida. *Alachua County*: Newnan's Lake, Gainesville, May 18, 1930, 3 ♂, C. F. Byers (Byers collection), *Clay County:* Gold Head Branch State Park, February 1939, 1 ♀, reared by J. G. Needham (Cornell); Kingsley Lake, May 1935, 6 ♂ 3 ♀, reared by C. F. Byers (Byers collection). *Orange County*: Winter Park, 1 ♂, E. M. Davis (Byers collection). *Volusia County*: Benson Springs [formerly Enterprise], April 22, 1921, 1 ♂, J. H. Williamson (University of Michigan), April 26, 1921, 2 ♂, J. H. Williamson (University of Michigan). *Lake County:* Lake Harris, August 5, 1938, 1 ♂, Hubbell and Friauf (University of Michigan).

Diagnostic characters.

Head (fig. 3. Pl. 1).—Top of frons long (4.5 mm.), oval; hind margin of occiput straight, mediumally thick.

Thorax (fig. 2, Pl. III).—Pale humeral stripe usually separated from the pale area of the mesothoracic collar, edge jagged, tapering to a point, dorsal area between dark brown. Pale antehumeral stripe usually absent, occasionally present as a very faint line. Pale spots above antealar carina present.

Abdomen.—Pale dorsal pattern on segments 3-7 extensive, usually distinct. Segment 8, sides golden brown, dorsum somewhat darker, no distinct pattern. Segments 9-10 practically uniform dark brown—no yellow spots. No tubercles present on venter of segment 1; a median spine present in males. Vulvar lamina of female (fig. 3. Pl. II) with deep U-shaped central notch.

Appendages male (fig. 6. Pl. II).—Superior abdominal appendages long (2.8 mm.), slender, somewhat pointed apically (fig. 6. Pl. 1), a single row of denticles on inferior margin, the carina extending to the last denticle; color, base brown, tips yellow. Inferior appendages slender and pointed.

Wings.—Brown basal stripe in costal and subcostal spaces reaching to the first antenodal cross-vein or nearly so; a trace of brown between the sectors of the arculus at their origin. Stigma brown, 5 mm. long in males, 5-6 mm. long in females. Wing venation not as dense as in *P. borealis* (see analysis tables).

Size.—Medium (average length of abdomen 38 mm.), proportions slender. In general, *P. alachuensis* is a medium large, slender, dark *Progomphus*.

VARIATION. A study of the paratypes and the other material examined (see page 67) indicated the following variations:

In the thoracic pattern, the sides of the humeral stripe exhibit degrees of serration from those that are quite jagged (fig. 2. Pl. III) to the condition found in four males in which the sides of this pale stripe are simply sinuate. In these same four males and an additional female the pale humeral stripe is narrowly and faintly joined to the pale area of the mesothoracic collar. In a few specimens studied (.76%) there is a very faint suggestion of a fine antehumeral stripe in addition to the faint spot above the antealar carina. In the abdominal pattern the dorsal areas show some variation in the extent of the pale markings which is difficult to measure; the females, in general, have the more extensive light areas.

Venation based on 36 ♂ fore and hind wings and 16 ♀ fore and hind wings (18 ♂ and 8 ♀ specimens), varies as follows:

TABLE 6
CROSS VEINS

	NUMBER		AVERAGE		TYPE	
	♂	♀	♂	♀	♂	♀
Anq of fore wings	14-16	14-17	14.97	16.00	15-16	17
Anq of hind wings	10-13	11-14	11.44	12.30	10-11	13-14
Pnq of fore wings	7-10	7-9	8.11	8.14	8-9	8-9
Pnq of hind wings	8-10	7-11	9.03	8.60	9-10	9-11
Scq in all wings	1 in all counted except in left fore wing and hind wing of allotype ♀ and left hind wing of 1 ♂ in which it is absent.					
Scq in all wings	1 present in 87 wings; 2 present in 17 wings.					
Distal thickened Anq	the 5th in 99 wings, 6th in 5 wings (4.5%).					

TABLE 7
CELLS

	♂		♀		SAME IN BOTH	
	Fore wing	Hind wing	Fore wing	Hind wing	Fore wing	Hind wing
Triangle						
1 celled (open)	0	0	0	0		
2 celled	5	21*	0	7*	1 ♂	9 ♂* 2 ♀*
3 celled	31*	15	16*	9		6 ♂ 3 ♀
Subtriangle:						
1 celled	0	11*	0	6		3 ♂ 2 ♀
2 celled	36*	25*	16*	10*	18 ♂* 8 ♀*	10 ♂ 4 ♀*
3 celled	0	0	0	0		
Supratriangle:						
1 celled	36*	36*	16*	16*	all males and females	

*includes holotype ♂ and allotype ♀

Stigma covers cells: Male fore wing 5-7 (aver. 8.11); hind wing 5-8 (aver. 6.20). Female fore wing 6-8 (aver. 7.70); hind wing 6-7 (aver. 7.20).

Anal field of fore wing proximal to triangle 2 cells wide for a distance of from 3 to 6 cells (approximate average 5); these may be so irregularly arranged as to make counting difficult.

Measurements (in millimeters).—Abdomen (including appendages) male 38-40 (aver. 38.82); female 37-40 (aver. 38). Length of hind wing male 30-32 (aver. 31.33); female 31-35 (aver. 32.25). Length of stigma male 5 (aver. 5); female 5-6 (aver. 5.6).

Ecological notes.—*P. alachuensis* is a new species of *Progomphus* restricted, as far as our records indicate, to the central group of Florida counties (Clay and Alachua on the north to Orange, Volusia and Lake on the south). South of Alachua County it seems to be the only *Progomphus* in the dragonfly fauna; while in north and west Florida *P. obscurus* alone is present. Thus, the new species overlaps with *P. obscurus* in Alachua and Clay Counties at least.

All available records for *P. alachuensis,* adult, nymph or reared, indicate a lake-pond habitat, chiefly lake. Adults are comparatively rare and are to be found flying along the lake shore and low among the plants of the shore zone or pond margin. Collection of adults has been made from April to August; the peak of emergence seemingly coming in May. In most respects the adults behave like *obscurus.*

J. H. Williamson notes on the envelope of a male specimen (No. 21 U. of Mich. coll.) taken April 22, 1921, at Enterprise (now Benson Springs), "New Gomphine. Only one seen. Was flying nervously about a small open space among small pine trees near Figure 8 pond and just as I approached to size him up, lit on a dried bit of vegetation (like clover tip)."

The nymphs are found burrowing in the white sand bottom of lake shores in fairly shallow water (up to about 3 feet) where they act in a manner identical with those of *P. obscurus* (Byers 1930: 247. The lake inhabiting nymphs referred to are those of *P. alachuensis.*) Nymphs are common and have been collected in Newnans and Wauberg Lakes, Alachua County, along with the rarer "long-tailed" nymph —*Gomphoides williamsoni* Gloyd.

Needham (1897) received a collection of Odonata from Orange Co., Florida including a *Progomphus.* Though the present author has not seen this material, it is his belief, based on collector's data from Orange County, that the species is *alachuensis* rather than *obscurus.*

Davis and Fluno (1938) state, "*Gomphoides (Progomphus) obscura* (Rambur). Found always on sandy shores of local lakes [Winter Park, Orange Co.], fairly common Apr. to Aug."

P. alachuensis is ecologically distinct from *P. obscurus* as far as the writer's experience may indicate. In the region studied, chiefly Alachua County, *P. alachuensis* is a *lake-pond* species; *P. obscurus* is an inhabitant of sand bottom streams. The situation is of interest, not only within itself, but also, when compared with that exhibited by the dragonflies of the genus *Neurocordulia* (Byers 1937). In *Neurocordulia* the northern species inhabit the lakes and streams where the nymphs can find the required rocky conditions; the southern species occur only in similar habitats in streams. Temperature may be the factor involved—the southern lakes being too warm. The northern *Progomphus* also may be found in lakes or streams (generally lakes—as in many regions the streams have rock or gravel bottoms); in the south, the northern *P. obscurus* is an inhabitant of the cooler streams, while the new species (*P. alachuensis*) has come in to occupy the sand bottom habitat of the warmer lakes. In the warmer southern part of Florida, *P. obscurus* seems to be absent.

P. alachuensis was named after the type locality—Alachua County, Florida.

THE IMMATURE STAGES OF NORTH AMERICAN PROGOMPHUS

The nymphs of the genus *Progomphus* are best known for their ability to burrow rapidly in the sands of river and lake bottoms. This habit is correlated with marked structural adaptations. In general, these nymphs may be separated from other North American Gomphinae by the following set of characters:

Third segment of the antennae cylindrical, not greatly flattened; the 4th segment from one-third to one-half as long as the third, apex tapering and upturned; apex of lateral lobe rounded; middle coxae more approximate than the fore or hind ones; abdomen long and slender, 9th segment with a dorsal spine.

A more detailed description of the nymph based on reared Florida material (see material studied p. 67) of *P. obscurus* in the author's collection follows:[9]

Description of Progomphus Nymph[10]

Head heart-shaped, depressed, sloping anteriorly, broadly notched behind; hind angles rounded. Antennae inserted into cylindroid elevations on the front, depressed and incurved; two basal joints very short; terminal segment (4th) long and decidedly upturned; third

[9]The italics indicate special *P. obscurus* characters; non-italicised portions are applicable to the genus as far as the nymphs of the various species are known.

[10]For figures of the nymph see references under the various species given on pages 60 and 63.

segment *3-5 times* longer than the terminal one, slightly flattened and hairy. Labium rather small, reaching when folded to the base of the middle legs; median lobe short and square, its cephalic border convex and fringed with one series of short hairs overlying small denticles; lateral lobes short, nearly straight, apex rounded, margins entire, movable hooks stout and slightly incurved.

Thorax sloping to the head and the bases of the legs. Wing cases strongly divergent. Legs conspicuously fossorial; fore legs approximate to the sides of the head, bearing shields of stiff hairs behind which the middle legs may be brought forward; middle legs with coxae closer together on the ventral surface than those of the fore and hind legs, rotated downward and extended horizontally close under the fore legs; hind legs longer and more nearly normal; tarsi and tarsal claws modified for digging; each femur with a distal anterior process which rests against and supports the tibia when moved backward.

Abdomen *long and narrow*, segments about equal, 9th a little longer than the others; dorsal spines on segments 1-9 varying in length on the different segments; lateral spines *on 5-9;* appendages slender, tapering; superior and inferiors about equal length, laterals about half as long.

Length 29mm.; length of abdomen *20mm.;* width of abdomen *6mm.;* length of hind femora *3mm.* General color light buff with *brownish* spots on either side of the abdomen.

Historical Survey

The first contribution made to our knowledge of the immature forms of *Progomphus* was that of Cabot (1872: 6-16); he correctly assigned certain nymphs from Wareham, Massachusetts, to this genus and published the first figures.

Hagen (1885:48) published a detailed description of the nymph of *P. obscurus* and in addition stated, "As *P. obscurus* has now been collected near Boston, by Mr. Morrison, there can scarcely be a doubt that the nymphae belong to this species." The material consisted of: "Three nymphae in alcohol, male and female, probably full grown, from Wareham, Mass., May, 1863 [Cabot's material], by Prof. L. Agassiz; one in alcohol from Little Wabash River, Effingham, Ill., June, 1878, Prof. S. A. Forbes." In this same paper (1885) Hagen lists under the name, " 32. *Progomphus species*" six nymphs from Santiago, California, which in view of our present knowledge, were undoubtedly those of *P. borealis*. This is the first published record of the nymphs of this western species.

In 1890, Wm. Beutenmuller published a catalogue of the immature forms of Odonata, he included both the Cabot and Hagen references given above.

Needham (1897) received from Orange County, Florida, some Odonata material collected by Mr. Adolph Hempel, April 21, 1897. Needham writes, "Mr. Hempel took a *Progomphus obscurus* Ramb., with its skin in transformation. While the nymph was known by fair supposition it appears not to have been reared before." It is the opinion of the present writer that this specimen was one belonging to the species *P. alachuensis*.

Needham and Hart (1901) described and figured the nymph of *P. obscurus* from Illinois and noted, "The nymph was described and by supposition connected with this species by Hagen (1885) and the supposition was verified by Mr. Needham (1897)."

Kennedy (1917 b) first described and figured the nymphs of *P. borealis* in sufficient detail to assign them to the correct species. Kennedy's work is still the most important in our knowledge of this species though he did not work from reared material.

Seeman (1927) indicated that *P. borealis* (she used the name *P. obscurus*), " . . . was reared in the laboratory at Pomona College."

Other contributions to our knowledge of *Progomphus* nymphs have been made by authors from time to time (see references under the various species treated on pages 40 and 46).

Key to the Known Species of Progomphus Nymphs

The determination of species of *Progomphus* in the immature stages is quite difficult; only *borealis* and *obscurus* are separable with any degree of ease. The following key attempts to separate the four known species—three of these have been reared, the fourth, *P. integer* is included on supposition. Hagen (1885), under the heading "31. *Progomphus* species", lists six nymphs from various regions of Brazil, the specific identity of which was then, and still is, impossible to establish, (See Cabot 1872 for a note on these specimens).

Key

1—*Lateral spines on abdominal segments* 3-9. Dorsal spines low and rounded on segments 4-9; high and well developed on segments 1-3. Fourth antennal segment nearly half as long as third. Length of hind femora (fully grown nymphs) 4mm. Body short and broad (length of abdomen 18-20mm., width 7mm.). Large black spots on dorsum of abdomen, especially on segment 7. Inhabit the shifting white sand beds of the rivers of western United States (western Texas and Colorado to northern Mexico and the Pacific) ..... *P. borealis.*

—*Lateral spines on abdominal segments* 5-9. Dorsal spines on abdominal segments 1-9 moderately or well developed. Fourth antennal segment from

one-half to one-third as long as the third antennal segment[11]. Length of hind femora (fully grown) 3mm. Body long and slender (length of abdomen 20-23 mm., width 5-6mm.). Markings on dorsum of abdomen brown, generally restricted, with isolated pale areas. Inhabit sand bottom regions of streams, lakes and rivers in eastern United States and Cuba.....(2)

2—*Dorsal spines on abdominal segments* 4-9 *long and sharp,* that on segment 9 about one-half as long as the dorsum of segment 10. Abdominal appendages relatively short (measured on ventral surface, about two-thirds the length of segment 10). Nymphs small and slender. Cuba.....*P. integer.*

—*Dorsal spines on abdominal segments* 4-9 *short and pointed,* that on segment 9 from one-fourth to one-third as long as the dorsum of segment 10. Abdominal appendages relatively long and pointed (measured on ventral surface, slightly longer than the length of segment 10). Nymphs long and slender. Eastern United States (Atlantic coast to eastern Texas and Colorado. ..... (3)

—Nymphs inhabiting streams in central Florida, lakes or streams elsewhere in eastern United States .....*P. obscurus.*

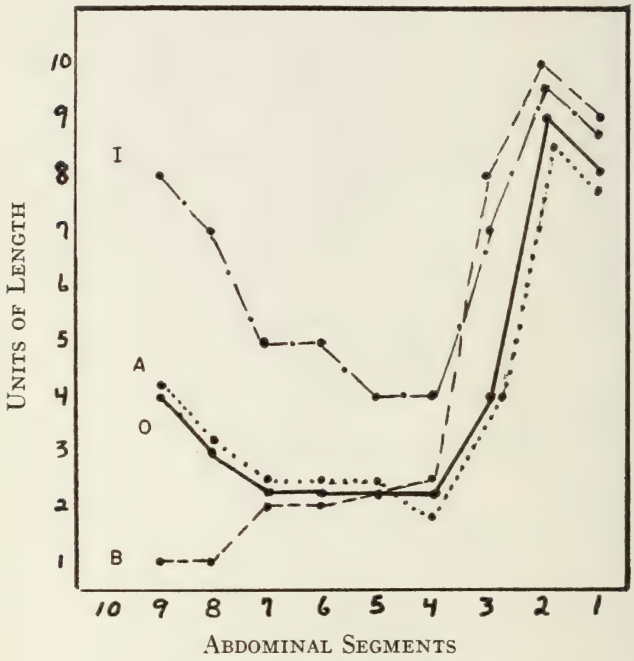
Discussion

After a careful and prolonged study of the various possible specific characters for the separation of the nymphs of *P. obscurus* and *P. alachuensis,* the conclusion has been reached that none exist. The nymphs of these two species are practically identical as far as it is possible to indicate differences in words. After long experience in handling material, the worker feels that slight undescribable differences do exist, but that they defy measurement or description.

Probably the dorsal spines of the four keyed species offer the best set of characters for judging degrees of similarity and difference—morphologically speaking. These spines are present on abdominal segments 1-9 and assume different degree of sharpness, length and height not only on the various abdominal segments of the same species, but in the different species as well. Some of these specific differences have been utilized in the above key; they are not sufficiently distinct, however, between *obscurus* and *alachuensis* to be so employed. To illustrate this condition, the accompanying graph has been drawn. The graph has been based on units of length of the dorsal spine (a unit is

[11]In nymphs of *obscurus* and *alachuensis,* at least, there is a sexual dimorphism exhibited in the comparative lengths of antennal segments 3 and 4. In males the ratio is 2.5: 1.0; in females it is 2.5: 1.5.

equal to a little less than a millimeter) shown in the vertical column; the horizontal base-line gives the number of the abdominal segment bearing the spine.



Nymph of *Progomphus obscurus*

Description and Figures.—Satisfactory descriptions, or diagnostic characters, and figures have been published by the following authors:

Byers (1930: 50). Description.

Cabot (1872: 6-16). Description. Figure (Pl. II, fig. 3).

P. Garman (1927: 126). Description. Figure (labium, Pl. V, fig. 7).

Hagen (1885: 274). Description.

Howe (1917: 127). Pictoral keys. Figure (labium, Pt. II).

Needham and Hart (1901: 55-56). Description. Figure (nymph, Pl. I, fig. 3).

Needham and Heywood (1929: 62). Diagnostic characters. Figure (nymph).

Needham and Needham (1927). Diagnostic characters. Figure (nymph, Pl. IV, fig. 8).

Ecological notes.—Probably more has been written on the habits of this species than on any other phase of the study of *Progomphus*, no doubt because of the unusual burrowing habits of the nymph.

Brimley (1903) writes, "A number of nymphs were observed transforming, from about 10 A. M. to 1 P. M. on June 5, 1900, resting on bare patches of sand or on the bare clay banks, close to the water's edge, but not climbing up plants."

Byers (1925) records the nymphs as, "Emerging in numbers in early July" along the sandy shores of Douglas Lake, Michigan. The same author (Byers 1930) records the nymphs as of "common occurrence" in Florida and continues to say:

> The nymphs are of much interest because of their ability as true sand burrowers. The fore and middle legs are especially fitted for this process. So efficiently do these legs operate that their possessor can become completely buried within a few seconds after being placed on a bed of clean sand. . . . Small white-sand bottom creeks, flowing through woods are their favorite abode. . . . As observed they always occur under moving water conditions. . . . In the laboratory, nymphs thrive better under moving water conditions, even though the sand has been previously cleaned. Two nymphs were reared in the laboratory. . . . Each molted once and on May 14 and 15 adults appeared. At this time in May cast skins began to appear out-of-doors. To emerge, the nymph crawls up the shore but a little way above the water line and continues the process directly from that position. One cast skin was found on a small sand shoal temporarily raised into a mid-stream island no longer than a dollar bill. The nymph had emerged so near the water line that its feet were practically wet during the process, although the skin was dry and in its customary position. The food [of the nymph] consists mainly of small annelid worms found in large numbers buried in the sand with them. . . These Odonata larvae may be considered as an ecological index to a habitat of clean sand underlying moving water.

Howe (1917—Pt. II Larva) states, "Larva [of *P. obscurus*] inhabit sandy ponds and river bottoms. Larval life occupies probably three years."

Kennedy (1917a) in discussing the distribution of *P. obscurus* in Kansas notes that the species, " . . . occurs wherever . . . there are sand-bedded streams, as its nymph is adapted to rapid burrowing in flowing sand; consequently it is abundant throughout western Kansas." In the same paper, Kennedy further notes that *P. obscurus* is ". . . found only on streams whose beds are loose, flowing sand, in which the highly specialized nymph burrows".

Kennedy (1921) writing about some dragonfly nymphs sent to him from eastern Texas (Colleto Creek, Victoria, July 20, 1920) states,

"The material consists of 35 naiads. . . . The largest two . . . would undoubtedly have emerged during the season of 1920, as the *Progomphus* season is a long one. Whether the numerous smaller examples would have emerged the same season or one or two seasons later is impossible to say, as so little is known concerning the life history of *Progomphus*. Burrowing insects in general are slow feeders and consequently slow growers."

Needham and Hart (1901) write, "The nymph of this species . . . represents an extreme specialization for life as a burrower in the bed of running streams . . . it is common in the sand of smaller rivers . . . one specimen was found at the lower edge of a sand-bar in the Spoon River [Illinois]). Perhaps the peculiar habits of the nymph may be correlated with a relatively long period of nymphal life and a short period of life as an imago." Needham, in several papers, records the nymph of *obscurus* as an inhabitant of "rapid streams", "lotic waters", etc. (see 1901, 1903b, 1927, 1929), as do other authors after him.

Williamson (1901) observes that "A half dozen exuviae were gathered on the sand beaches near the water's edge [Chapman Lake, Indiana, June 30, 1901]."

In summarizing the foregoing, we may say that the nymphs of *Progomphus obscurus* are:

1—Highly adapted for burrowing in the clean sand-bottoms of streams, rivers and lakes, (Pl. VI, fig. 2).

2—Associated under these conditions with more or less rapidly moving water.

3—Found emerging near the water's edge directly from bare patches of sand, river banks, lake shores, etc. Not found emerging from vegetation, the sides of wharves, far from water, etc.

4—Generally common in their proper habitat.

5—Slow feeders, slow growers, with long larval life.

Dr. Kennedy (1921) made a phylogenetic study of *Progomphus* nymphs based on material (already noted) that he received from eastern Texas. His *P. obscurus* specimens—35 in all—ranged in length from 7mm. to 28mm., the two largest being 25 and 28mm.; some 20 of these specimens were broken, thus making a table of measurements impossible. Regarding this collection he writes:

> The small specimens are the smallest *Progomphus* naiads the writer has seen, and are interesting in that they show, by the way the mature naiads differ from them, the direction in which the latter are specialized . . . The specimens 7mm. long differ from the mature naiads [25-28mm. long] as follows:
>
> 1. The wing pads are minute triangular flaps.
> 2. The dorsal spines on segments 2 and 3 are lacking.

3. The superior pair of anal appendages are mere tubercles.

4. The fourth segment of the antennae is only one-third as long as the third. (In mature naiads it is nearly one-half as long as segment 3).

5. Labium with two triangular teeth on the middle lobe besides the usual row of truncate teeth. (In the adult [sic] there are not noticeable triangular teeth).

6. Lateral lobe with several broad though shallow teeth.

It can be legitimately inferred that these ontogenetic changes point out the phylogeny of this most specialized of burrowing Odonate naiads. They must have developed through a Gomphus-like form that had the characteristics of the very young naiads. It is interesting to note that these specializations have developed more in the naiads of *P. borealis,* and that on the naiadal characters alone *obscurus* is more generalized than *borealis.* This pair of species agrees with *Amphiagrion* and a number of other pairs of closely related species of Odonata in which the western form is more specialized than the eastern. It is interesting to those studying distribution to find that these *obscurus* naiads from Texas, where both *obscurus* and *borealis* are found, are in no wise intermediate in character between the two species but are true *obscurus* naiads.

Nymph of Progomphus borealis

Description and Figures—Satisfactory descriptions, or diagnostic characters, and figures have been published by the following authors:

Hagen (1885: 275). Diagnostic characters: species not named.

Kennedy (1917b: 527-529). Good description. Figures (nymph, first leg, mentum detail, head, labium, segments 9-10 of male and female, figs. 155-163, page 528).

Ecological notes.—The most important, and virtually the only, contribution made to our knowledge of the nymphs of *P. borealis* was that of Kennedy (1917b). Regarding their habits in southern California he writes:

> These nymphs seem to occur in the drifting beds of all the sand-bottomed streams of central and southern California where there is a permanent flow of water . . . . The nymph of this species is more highly specialized for burrowing than any other odonata nymph with which I am familiar. It is the most frequently occurring form of large insect life found in the sand beds of the rivers of central and southern California. All of the rivers of California originate in the mountains as swift, clear streams, but nearly all before reaching the sea have almost level lower courses where they lose their swiftness, become warm and meander over beds of shifting white sands. These sand beds are so unstable that they actually flow with the water though at a much slower rate . . . . in such a stream the bottom inch of water is turbid with moving sand. It is in such an unstable environment that *Progomphus* flourishes. Only once or twice have I actually found nymphs in the flowing streams, but in any side channel where the water has ceased to flow the sand is marked in all directions by the curving burrows of these wandering nymphs. They burrow in the loose upper stratum of the sand and just deep enough to cover the back. Usually the tenth segment protrudes. I have traced burrow tracks that were from ten to fifty feet long. If one

arrived at the fresh end of a burrow before some water fowl had found it the nymph would be found spasmodically burrowing forward. These nymphs could burrow as rapidly as the average nymph can walk. Only such vigor and speed could save an insect of this size from being buried in the moving sand.

The following authors have added to or substantiated Dr. Kennedy's work on *P. borealis*:

Seeman (1927) writes, "The nymph lives in the shifting sand bars of streams. In the Santa Ana River, in the sandy shallows near the shore, a pint jar might have been filled in a short time so abundant were they. They burrow out of sight so rapidly that when once uncovered, one must work quickly or *Progomphus* has buried himself in the sand and is out of sight like a flash."

Needham and Heywood (1929) note, "The senior author found nymphs of this species exceedingly abundant in the sandy bed of the Santa Ana River below Riverside, California, in April. A dozen or more could be taken at each sweep of the sieve-net on the bottom."

Tinkham (1934) writes, "The Cibolo Creek at Shafter [southwest Texas] supported *Progomphus* as the commonest species. At Wilson's Ranch, 25 miles southeast of Marfa [Texas], a number of Gomphoid naiads were found burrowing in the sand of the Alamito Creek bed leaving long meandering trails behind them. These were probably *Progomphus* . . . . but there were no adults in the air at this time in late May."

From the foregoing accounts, it will be seen that the habits of *P. borealis* are very similar to those of *P. obscurus*.. However, several points of difference may be noted:

1) No mention is made of finding *P. borealis* in lakes. They seem to be restricted to the quieter portions of rivers and streams.

2) The production of meandering burrows visible and traceable on the sand bottom surface. No author has recorded, nor have I seen, burrows of this nature for *P. obscurus*.

3) The more specialized burrowing adaptation in *P. borealis*. It would be interesting to time the burrowing speed of both *P. borealis* and *P. obscurus* respectively to see which was the more rapid.

Nymph of Progomphus alachuensis

The nymphs of *P. alachuensis* are structurally (see key page 58) and ecologically similar to those of *P. obscurus* with the notable exception that, in the Florida area where the ranges of the two species overlap, *alachuensis* is a lake-dweller and *obscurus* is found restricted to streams.

The morphological similarity of the nymphs of these two species (*alachuensis* and *obscurus*) together with their geographic distribution

and ecological peculiarities opens some interesting lines of speculation. The following facts and hypothesis may be utilized in an attempted explanation.

1). *P. obscurus* and *P. borealis* are both widely distributed species and the morphological differences between them in both nymphal and adult stages are marked.

2). Of these two species (*obscurus* and *borealis*), *P. obscurus* appears to be the most primitive (Kennedy 1921). Therefore, we may assume that *borealis* was derived from *obscurus* at some time sufficiently long ago to permit its wide spread distribution, distinct characters, and absence of intermediates in the region (Texas) where it contacts the range of *obscurus*.

3). Associated with *obscurus,* on the basis of nymphal similarities (see key page 58), are *alachuensis* and *integer*. In the adult stage these are distinct enough and are undoubtedly good species. However, in the nymphal stages they converge in such a manner that the nymphs of *integer* are quite similar to those of *obscurus,* but with a marked set of minor characters (see graph of dorsal spines page 60); while the nymphs of *alachuensis* are practically identical with those of *obscurus*.

4). Both *P. integer* of Cuba and *P. alachuensis* of central Florida are limited in distribution. The geological history of the Antillean region indicates that both Cuba and an area of central Florida are or were at one time islands. This Central Florida area just about delimits the present range of *alachuensis*.

5). Applying the concept of isolation in the formation of species and the role that islands play in this process, we may perhaps assume that originally *integer* and *alachuensis* were isolated reminants of an eastern North American *Progomphus* stock, and that subsequent speciation resulted from mutation and isolation. Thus, three species resulted, *P. obscurus* on the mainland, *P. alachuensis* on the Central Florida Island, and *P. integer* on Cuba.

6). The reunion of the Central Florida Island (Pleistocene) with the mainland of North America brought the ranges of *P. obscurus* and *P. alachuensis* in contact with each other. The separation, however, remained long enough for adult specific characters to be produced but not long enough for nymphal ones to arise.

7). On the reunion of the two land masses, *P. obscurus* invaded north and north central Florida. In north central Florida the invading species overlapped the range of the endemic one but remained ecologically distinct, inhabiting the rivers and streams, leaving the lakes for the species already established.

8). The isolation of *P. integer* has continued with consequent accumulation of specific differences extending to the nymphal stage.

There are other explanations for the *P. obscurus-P. alachuensis* relationship—perhaps simpler ones. For example, *P. alachuensis* may be a far more modern species than is assumed in the above hypothesis, and have been separated from *P. obscurus* through ecological isolation exclusively; isolation, in the sense that the Florida endemic species is adapted to somewhat warmer lakes and *P. obscurus* can establish itself only in the cooler streams of north and north central Florida.

MATERIAL STUDIED

The following listed material was studied or examined by the author in the preparation of this paper:

Adults

Progomphus obscurus:

Florida: Alachua Co., Gainesville, April 2, 1923, 1 ♂, T. H. Hubbell (Byers coll.), May 14, 1928, 1 ♂, May 30, 1929, 1 ♂, May, 1933, 1 ♂, July 7, 1935 (Hog Town Creek) 2 ♂, July 12, 1935, 1 ♀; Hawthorne (Magnesia Springs), May 16, 1932, 2 ♂, May 25, 1935, 1 ♂, C. F. Byers (Byers coll.). Jackson Co., Chipola River, April 13, 1935, 1 ♀, Bellamy (Byers coll.). Liberty Co., Camp Torreya, May 30, 1924, 1 ♀, May 31, 1924, 1 ♂ 1 ♀, June 1, 1924, 1 ♀, C. F. Byers (Byers Coll.). *Georgia:* Johnson Co., Keysville, June 28, 1930, 4 ♂, C. F. Byers (Univ. of Mich. coll.). Wayne Co., Jesup, June 22, 1930, 1 ♂, June 23, 1930, 4 ♂, C. F. Byers (Univ. of Mich. coll.). *Kentucky:* Powell Co., Walthersville, Red River, Aug. 1, 1929, 2 ♂, Aug. 2, 1929, 3 ♂, Jean Lowry, Thornton Scott, E. B. Williamson, (Univ. of Mich. coll.). *Indiana*: Allen Co., Devils Hollow, July 9, 1922, 1 ♀, E. B. Williamson (Univ. of Mich. coll.). Wells Co., Bluffton, June 22, 1921, 1 ♂ 1 ♀, E. B. Williamson (Univ. of Mich. coll.). *Michigan*: Cheboygan Co., Douglas Lake, July 8, 1924, 1 ♂ 1 ♀, C. F. Byers (Byers coll.). *Arkansas:* Lincoln Co., July 5, 1931, 4 ♂, July 9, 1931, 6 ♂, L. H. Bridwell (Univ. of Mich. coll.). *Missouri*: Carter Co., June 21, 1930, 3 ♂, E. B. Williamson, et al. (Univ. of Mich. coll.). Stoddard Co., Dexter, July 17, 1930, 24 ♂ 4 ♀, E. B. Williamson, et. al. (Univ. of Mich. coll.).

Progomphus borealis:

Arizona: Granite Reef Dam, Sept. 22, 1912, 1 ♂, Sept. 15, 1912, 1 ♀, B. J. Rainey (Univ. of Mich. coll.). Oslar, Salt River, April 12, 1902, 1 ♂ 1 ♀, (Univ. of Mich. coll.). Pima Co., Catalina Mts., Aug. 6, 1930, 2 ♂, L. K. Gloyd (Univ. of Mich. coll.). *California*: Chico, June 17, 1914, 1 ♂, C. H. Kennedy, (Univ. of Mich. coll.). Oroville, June 13, 1914, 1 ♂, C H. Kennedy (Univ. of Mich. coll.). *Utah*: St. George, June 6, 1919, 1 ♂, Tom Spalding (Univ. of Mich. coll.). *New Mexico*: Albuquerque, April 18, 1903, 1 ♀, Oslar? (Univ. of Mich. coll.). *Texas*: Davis Mountains, Fort Davis Quad., Phantom Lake, June 1,

1916, 2 ♂ 1 ♀, June 9, 1916, 5 ♂ 2 ♀, July 13, 1916, 1 ♂, F. M. Gaige (University of Mich. coll.). *Mexico-Baja California*: Purissima, Oct. 13, 1923, 1 ♀, J. H. Williamson (Univ. of Mich. coll.). *Mexico-Sonora*: Hermosillo, Sept. 25, 1923, 1 ♂ 1 ♀, J. H. Williamson (Univ. of Mich. coll.).

Progomphus alachuensis: (In addition to types and paratypes).

Florida: Alachua Co., Newnan's Lake, Gainesville, May 15, 1931, 1 ♂, C. F. Byers (Byers coll.). Clay Co., Kingsley Lake, May 1935, 2 ♂ 2 ♀, reared by C. F. Byers (Byers coll.). Volusia Co., Benson Springs (Enterprise) April 21, 1921, 1 ♀, J. H. Williamson (Univ. of Mich. coll.), April 26, 1921, 1 ♂, J. H. Williamson (Univ. of Mich. coll.).

Progomphus clendoni:[12]

Guatemala: Agua Caliente, June 1, 1909, 1 ♂, E. B. Williamson, Amatitlan, June 8, 1909, 1 ♂, E. B. Williamson. El Fiscal, June 6, 1909, 1 ♂, E. B. Williamson Los Amates, June 19 1909, 1 ♂, E. B. Williamson. Puerto Barrios, May 28-30, 1909, 3 ♂, E. B. Williamson. *Mexico*: Hacienda de San Marcos, near Villegas, State of Jalisco, Nov. 22, 1923, 1 ♂, J. H. Williamson. Acaponeta, State of Nayarit, Nov. 2, 1923, 1 ♂, J. H Williamson.

Progomphus intricatus:

Brazil: Chapada, December, 1 ♂, H. H. Smith.

Progomphus joergenseni:

Argentina: Chacras de Coria, March 5, 1907, 2 ♂; March 9, 1907, 1 ♀.

Progomphus phyllochromus:

Colombia: Vista Nieve, Mt. San Lorenzo, Santa Marta Mts., June 15, 1920, 4 ♂ 1 ♀, F. M. Gaige.

Progomphus pygmaeus:

Colombia: Bolivar, Dec. 24-25, 1916, 10 ♂ 3 ♀, E. B. and J. H. Williamson.

Progomphus risi:

Guatemala: Gualan, June 16, 1909, 2 ♂ 1 ♀ (Types and paratype), E. B. Williamson.

Progomphus dorsopallidus:

Venezuela: San Esteban, Feb. 5-6, 1920, 4 ♂ (type and paratypes), J. H. and E. B. Williamson, W. H. Ditzler.

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Progomphus obscurus:

Florida: Alachua Co., Gainesville, Rattlesnake Branch, April 10, 1925, 1, T. H. Hubbell; "C-creek", May 2, 1928, 15, February 21, 1930, 7, March 1,

[12]All of the following specimens for South American and Central American localities are in the University of Michigan collection.

1930, 4; Santa Fe River, November 10, 1931, 10; city environs, May 14, 1928, 2 (reared ♂s), C F. Byers (Byers coll.). *Michigan*: Washtenaw Co., Whitmore Lake, October 1923, 8; Ann Arbor, 1925, 15 exuviae, C. F. Byers (Byers Coll.). Cheboygan Co., Douglas Lake, July 8, 1924, 1 (reared ♂) C. F. Byers (Byers coll.). *Oklahoma*: Camp Boulder, Wichita Mts., June 12, 1926, 1, T. H. Hubbell (Byers coll.).

Progomphus borealis:

Arizona: Tucson, 2, J. G. Needham (Cornell coll.).

Progomphus alachuensis:

Florida: Alachua Co., Gainesville, Wauberg Lake, April 29, 1933, 1 (reared ♂), R. Trogdon (Byers coll.). Clay Co., Gold Head Branch State Park, February 1939, 1, (reared ♀), J. G. Needham (Cornell coll.). Kingsley Lake, May 1935, 13 (8♂5♀ reared), C. F. Byers (Byers coll.).

Progomphus integer:

Cuba: Solidad, 5, J. G. Needham (Cornell coll.).

BIBLIOGRAPHY

Beutenmuller, William.

1890. "Preliminary Catalogue of the Described Transformations of the Odonata of the World. In Dragonflies vs. Mosquitoes," *The Lamborn Prize Essays. New York*, pp. 165-179.

Bird, Ralph D.

1932. "Dragonflies of Oklahoma," *Univ. of Okla. Publications*, Vol. 4, pp. 50-57.

Borror, D. J.

1935. "New Records of Ohio Dragonflies," *Ohio Journ. Sci.*, Vol. 35, pp. 451-456.

1937. "An Annotated List of the Dragonflies (Odonata) of Ohio," *Ohio Journ. Sci.*, Vol. 37, pp. 185-196.

Brimley, C. S.

1903.,"A List of Dragonflies from North Carolina. Especially from the Vicinity of Raleigh," *Ent. News*, Vol. 14, pp. 150-157.

1908. "North Carolina Records of Odonata for 1906 and 1907," *Ent. News*, Vol. 19, pp. 134.

1918. "Records of North Carolina Odonata from 1908 to 1917," *Ent. News*, Vol. 29, pp. 227-229.

1938. "The Insects of North Carolina," *N. C. Dept. of Agriculture, Div. of Ent.*, pp. 5-560.

Brown, C. J. D.

1934. "A Preliminary List of Utah Odonata," *Occ. Papers Mus. Zool. Univ. Mich.*, No. 291, pp. 1-17.

Byers, C. Francis.

1925. "Odonata Collected in Cheboygan and Emmet Counties, Michigan," *Papers Mich. Acad. Sci., Arts, and Letters*, Vol. 5, pp. 389-398.

1927. "An Annotated List of the Odonata of Michigan," *Occ. Papers Mus. Zool. Univ. Mich.*, No. 183, pp. 1-16.
1930. "A Contribution to the Knowledge of Florida Odonata," *Univ. Florida Publ., Biol. Ser.*, No. 1, pp. 1-327.
1931. "Dixie Dragonflies Collected During the Summer of 1930," *Ent. News*, Vol. 42, pp. 113-119.
1934a. "Records of Florida Dragonflies—1," *Ent. News*, Vol. 45, pp. 214-216.
1934b. "Progomphus dorsopallidus, a New Species from Venezuela," *Occ. Papers Mus. Zool. Univ. Mich.*, No. 294, pp. 1-5.
1937. "A Review of the Dragonflies of the Genera Neurocordulia and Platycordulia," *Misc. Pub. Mus. Zool. Univ. of Mich.*, No. 30, pp. 1-36.

Butler, Hortense.

1904. "The Labium of the Odonata," *Trans. Amer. Ent. Soc.*, Vol. 30, pp. 111-134.

Cabot, Louis.

1872. "The Immature State of the Odonata. Part 1. Subfamily Gomphina," *Illustrated Catalogue Mus. Comp. Zool., Harvard College*, Vol. 5, pp. 1-17.

Calvert, Philip P.

1895. "The Odonata of Baja California, Mexico," *Proc. Cal. Acad. Sci.*, (2) Vol. 4, pp. 463-558.
1901. "Odonata, in: Biologia Centrali Americana. 2, Insecta Neuroptera," pp. i-xxx, 17-342; supplement 342-420. London, 1901-1908.
1905. "Fauna of New England. 6. List of the Odonata," *Occ. Papers Boston Soc. Nat. Hist.*, Vol. 7, pp. 1-43.
1909. "Contributions to a Knowledge of the Odonata of the Neotropical Region, Exclusive of Mexico and Central America," *Ann. Carnegie Mus. Pittsburg*, Vol. 6, pp. 73-280.
1910. "The Insects of New Jersey. Order Odonata," *Ann. Report N. J. State Mus. for 1909*, pp. 73-82.
1923. "The Geographical Distribution of Insects and the Age and Area Hypothesis of Dr. J. C. Willis," *American Naturalist*, Vol. 57, pp. 218-229.

Cowley, J.

1934. "Notes on Some Generic Names of Odonata," *Ent. Monthly Mag.*, Vol. 70, pp. 240-247.

Currie, R. P.

1903. "The Odonata Collected by Messrs. Schwarz and Barber in Arizona and New Mexico," *Proc. Ent. Soc., Washington*, Vol. 5, pp. 298-303.

Davis, E. M., and J. A. Fluno.

1938. "Odonata at Winter Park, Florida," *Ent. News*, Vol. 49, pp. 44-47.

Davis, W. T.

1913. "Dragonflies of the Vicinity of New York City with a Description of a New Species," *Journ. N. Y. Ent. Soc.*, Vol. 21, pp. 11-29.

De Selys Longchamps, Edm.

1850. "Revue Des Odonates ou Libellules d'Europe," *Mem. Soc. Sci. Liege,* Vol. 6, pp. XXII-408.
1854. "Synopsis des Gomphines," *Bull. Acad. Belg.* (2) Vol. 21, pp. 23-112.
1858. "Monographie des Gomphines," *Mem. Soc. Sci. Liege,* Vol. II, pp. 257-720.
1873. "Troisiemes Additions au Synopsis des Gomphines," *Bull. Acad. Belg.* (2) Vol. 35, pp. 732-744.
1878. "Quatriemes Additions au Synopsis des Gomphines," *Bull. Acad. Belg.* (2), Vol. 46, pp. 408-698.
1879. "Revision des Ophiogomphus et Descriptions de Quatre Nouvelles Gomphines Americaines," *Extrait des Comptes-Rendus de la Societe Entomologique de Belgique.* Seance du Mai 1879.

Evans, A. T.

1915. "Dragonflies of the Douglas Lake Region, Michigan," *Mich. Geol. and Biol. Survey, Pub.* 20, *Biol. Series,* Vol. 4, pp. 39-57.

Fraser, F. C.

1929. "A Revision of the Fissilabioidae," 2 Parts. *Mem. Indian Mus.,* Vol. 9, pp. 69-167 and pp. 205-260. 1929-1933.

Garman, H.

1924. "Odonata from Kentucky," *Ent. News,* Vol. 35, pp. 285-288.

Garman, Philip.

1927. "Guide to the Insects of Connecticut. Part V. The Odonata or Dragonflies of Connecticut," *State Geol. and Nat. Hist. Surv. Bull.,* Vol. 39, pp. 1-327.

Hagen, H. A.

1861. "Synopsis of the Neuroptera of North America," *Washington: Smithsonian Inst.,* pp. 1-347.
1874. "The Odonata Fauna of Georgia," *Proc. Boston Soc. Nat. Hist.,* Vol. 16, pp. 349-365.
1875. "Synopsis of the Odonata of America," *Proc. Boston Soc. Nat. Hist.,* Vol. 18, pp. 20-96.
1885. "Monograph of the Earlier Stages of the Odonata," *Trans. Amer. Ent. Soc.,* Vol. 12, pp. 249-291.

Hine, J. S.

1900. "Additions and Corrections to the 'Odonata of Ohio'," *Ohio State Univ. Nat.,* Vol. 1, pp. 13.
1913. "Additions and Corrections to the 'Odonata of Ohio'," *Ohio State Univ. Nat.,* Vol. 13, pp. 94-96.

Hoffman, Charles.

1924. "The Odonata of Henry County (Iowa)," *Iowa Acad. Sci.,* Vol. 31, pp. 441-442.

Howe, R. H., Jr.
1917. "Manual of the Odonata of New England," *Mem. Thoreau Mus. Nat. Hist.*, II, pp. 1-138; *Mem. David Mason Little Memorial Mus. Nat. Hist.*, I, pp. 139-144. 1917-1927.
1919. "A List of the Dragonflies Collected at Wareham, Mass., During the Years 1911 to 1913 by Mr. Outram Bangs," *Psyche*, Vol. 26, pp. 65-68.
1920. "Odonata of Chatham, Massachusetts," *Psyche*, Vol. 27, pp. 57-60.
1921. "The Distribution of New England Odonata," *Proc. Boston Soc. Nat. Hist.*, Vol. 36, pp. 105-133.

Karsch, F.
1890. "Über Gomphiden." *Entomologische Nachrichten*, Vol. 16, pp. 370-382.

Kennedy, C. H.
1902. "A List of the Dragonflies of Winona Lake," *Proc. Indiana Acad. Sci.*, Vol. 12, pp. 162.
1917a. "Studies in Kansas Insects. The Dragonflies of Kansas," *Bull. Univ. of Kansas Biol. Ser.*, Vol. 18, pp. 127-145.
1917b "Notes on the Life History and Ecology of the Dragonflies (Odonata) of Central California and Nevada," *Proc. U. S. National Mus.*, Vol. 52, pp. 483-635.
1921. "Some Interesting Dragonfly Naiads from Texas," *Proc. U. S. National Mus.*, Vol. 59, pp. 595-598.
1928. "Evolutionary Level in Relation to Geographic, Seasonal and Diurnal Distribution of Insects," *Ecology*, Vol. 9, pp. 367-379.
1929. "The Theory of Nomenclature," *International Congress Ent. IV.*, Vol. 2, pp. 665-670.

Kirby, W. F.
1890. "A Synonymic Catalogue of Neuroptera Odonata or Dragonflies," *London*, pp. III-IX; 1-202.

Lew, G. Ting-Wei.
1934. "Head Characters of the Odonata," *Entomologica Americana*, Vol. 14, pp. 41-97.

Montgomery, B. Elwood.
1925. "Records of Indiana Dragonflies," *Proc. Indiana Acad. Sci.*, Pt. I—Vol. 34, pp. 383-388. Pt. II—Vol. 36, pp. 387-291. Pt. III—Vol. 38, pp. 335-343. Pt. IV—Vol. 39, pp. 309-314. Pt. V—Vol. 40, pp. 347-349. Pt. VI—Vol. 41, pp. 499-454. Pt. VII—Vol. 43. pp. 211-217, Pt. VIII—Vol. 44, pp. 231-235. Pt. IX—Vol. 46, pp. 203-210. 1925-1937.
1933. "Notes on New Jersey Dragonflies," *Ent. News*, Vol. 44, pp. 40-44.

Munchberg, Paul.
1932. "Beitrage zur Kenntnis der Biologie der Odonatenfamilie der Gomphidae Bks," *Zeitschrift für Morphologie und Okologie der Tiere*, 24. Band, 3/4 Heft, (20 Feb. 1932), pp. 704-735.

Muttkowski, R. A.
1908. "Review of the Dragonflies of Wisconsin," *Bull. Wisc. Nat. Hist. Soc.*, Vol. 6, pp. 57-127.

1910a. "Catalogue of the Odonata of North America," *Bull. Public Mus. Milwaukee,* Vol. I, pp. 1-207.

1910b. "The Applicability of Certain Generic Names in Odonata." *Bull. Wisc. Nat. Hist. Soc.,* Vol. 8, pp. 158-160.

NEEDHAM, JAMES G.

1897 "Preliminary Studies of North American Gomphinae," *Can. Ent.,* Vol. 29, pp. 164-168; 181-186.

1901. "Aquatic Insects of the Adirondacks," *Bull. N. Y. State Mus.,* No. 47, pp. 384-596.

1903a "A Genealogic Study of Dragonfly Wing Venation," *Proc. U. S. National Mus.,* Vol. 26, pp. 703-764.

1903b. "Aquatic Insects in New York State," *Bull. N. Y. State Mus.,* No. 68, pp. 199-499.

1926. "Order Odonata. In: A List of the Insects of New York with a List of the Spiders and Certain Other Allied Groups," by Mortimer Demarest Leonard. *Cornell Agric. Exp. Stat. Mem.,* Vol. 101, pp. 45-56.

NEEDHAM, J. G. AND MAUDE H. ANTHONY.

1903. "The Skewness of the Thorax in Odonata," *Journ. N. Y. Ent. Soc.,* Vol. II, pp. 117-124.

NEEDHAM, J. G. AND C. A. HART.

1901. "The Dragon-Flies (Odonata) of Illinois. Part I. Petaluridae, Aeschnidae, and Gomphidae," *Bull. Ill. State Lab. Nat. Hist.,* Vol. 6, pp. 194.

NEEDHAM, J. G. AND H. B. HEYWOOD.

1929. "A Handbook of the Dragonflies of North America," *Baltimore: Charles C. Thomas,* pp. 1-378.

NEEDHAM, J. G. AND P. R. NEEDHAM.

1927. "A Guide to the Study of Fresh-water Biology," *New York: American Viewpoint Society,* pp. 1-88.

O'BRIEN, A.

1911. "Odonata Collected at Douglas Lake, Michigan, in the Summer of 1910," *Ann. Rept. Mich. Acad. Sci., Arts, and Letters,* Vol. 13, pp. 144-145.

RAMBUR, M. P.

1842. "Histoire Naturelle des Insects. Neuroptères," *Suites a Buffon, Paris.*

RIS, F.

1908. "Beitrag zur Odonatenfauna von Argentina," *Deutsch. Ent. Zeitschr.,* pp. 518-531.

1911. "Über Einige Gomphinen von Südbrasilien und Argentina," *Mem. Soc. Ent. Belgique,* Vol. 19, pp. 101-119.

1916. "Libellen (Odonata) aus Region der Amerikanischen Kordilleren von Costarica bis Catamarca," *Archiv für Naturgeschichte,* Vol. 82, pp. 139-144.

Seeman, T. M.

1927. "Dragonflies, Mayflies, and Stoneflies of Southern California," *Journ. Ent. Zool. Pomona Coll.*, pp. 1-66.

St. Quentin, D.

1938. "Die Tibialleiste der Odonaten," *Zoologischer Anzeiger*, 1. 3. Band 121, pp. 226-239.

Tinkham, E. R.

1934. "The Dragonfly Fauna of Presidio and Jeff Davis Counties of the Big Bend Region of Trans-Pecos Texas," *Can. Ent.*, Vol. 66, pp. 213-218.

Williamson, E. B.

1899. "The Dragonflies of Indiana," *24th Ann. Rept. Dept. Geol. Nat. Res. Ind.*, pp. 231-333.

1901. "Additions to the Indiana List of Dragonflies with a Few Notes, II," *Proc. Indiana Acad. Sci.*, Vol. II, pp. 119-128.

1902. "A List of the Dragonflies of Western Pennsylvania," *Ent. News*, Vol. 13, pp. 65-71, 108-114.

1905. "Odonata, Astacidae and Unionidae Collected Along the Rockcastle River at Livingston, Kentucky," *Ohio Nat.*, Vol. 5, pp. 309-312.

1914. "September Dragonflies About Mesa, Arizona," *Ent. News*, Vol. 25, pp. 225-226.

1917. "An Annotated List of the Odonata of Indiana," *Misc. Pub. Mus. Zool. Univ. Mich.*, No. 2, pp. 5-12.

1920a. "Results of the Michigan-Williamson Expedition to Colombia, 1916-1917. Part V. Notes on Progomphus," *Occ. Papers Mus. Zool. Univ., Mich.*, No. 77, pp. 1-18.

1920b. "A New Gomphine Genus from British Guiana with a Note on the Classification of the Subfamily (Order Odonata)," *Occ. Papers Mus. Zool. Univ, Mich.*, No. 80, pp. 1-11.

1920c. "Notes on Indiana Dragonflies," *Proc. Indiana Acad. Sci.*, Vol. 30, pp. 99-104.

1932. "Dragonflies Collected in Missouri," *Occ. Papers Mus. Zool. Univ. Mich.*, No. 240, pp. 1-40.

Williamson, E. B. and J. H. Williamson.

1930. "Five New Mexican Dragonflies," *Occ. Papers Mus. Zool. Univ. Mich.*, No. 216, pp. 1-34.

Wilson, C. B.

1912. "Dragonflies of the Cumberland Valley in Kentucky and Tennessee," *Proc. U. S. National Mus.*, Vol. 43, pp. 189-200.

Wright, Mike.

1938. "A Review of the Literature on the Odonata of Tennessee," *Tenn. Acad. Sci.*, Vol. 13, pp. 26-33.

1939. "Additions to the List of Anisopterous Dragonflies of the Central Gulf Coast Region," *Tenn. Acad. Sci.*, Vol. 14, pp. 203-208.

Plate I

Figs. 1-3.—Top of head showing diagnostic characters of frons and occiput.

Fig. 1.—*Progomphus obscurus,* ♂, Dexter, Missouri.

Fig. 2.—*Progomphus borealis,* ♂, Baja California.

Fig. 3.—*Progomphus alachuensis,* ♀, Alachua County, Florida.

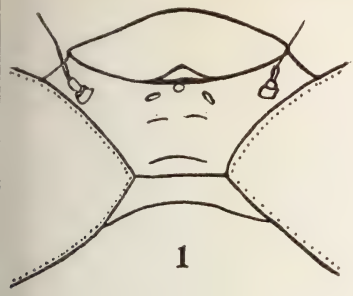
Figs. 4-6.—Male abdominal appendages, lateral view.

Fig. 4.—*Progomphus obscurus,* Dexter, Missouri.

Fig. 5.—*Progomphus borealis,* Pima County, Arizona.

Fig. 6.—*Progomphus alachuensis,* Alachua County, Florida.

Fig. 7. —Male genitalia of abdominal segment No. 2, ventral view. *Progomphus alachuensis,* Alachua County, Florida.



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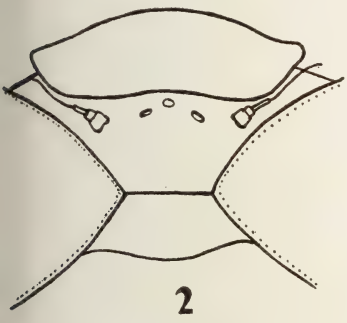

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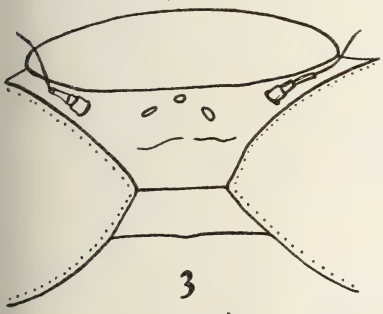

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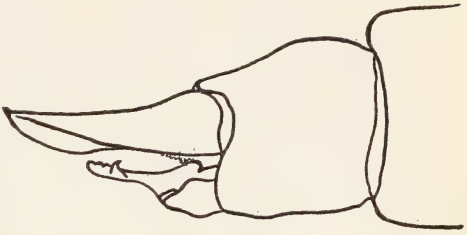

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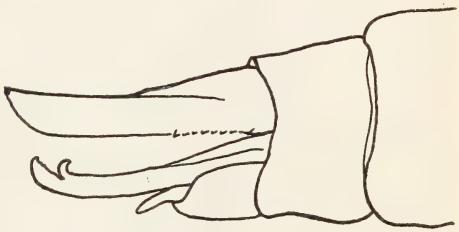

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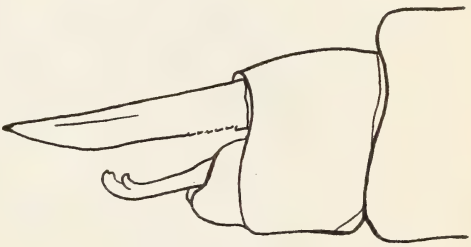

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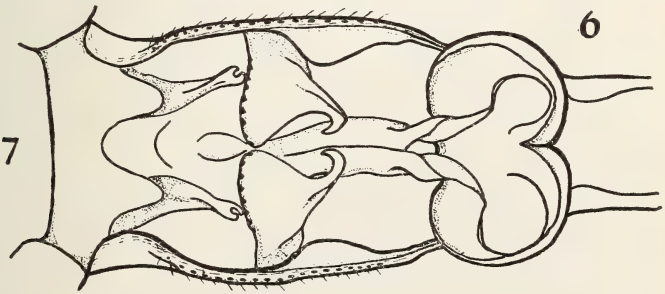

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Plate II

Figs. 1-3.—Ventral view of abdominal segment No. 9 of female showing vulvar lamina.

Fig. 1.—*Progomphus obscurus,* Dexter, Missouri.

Fig. 2.—*Progomphus borealis,* Baja, California.

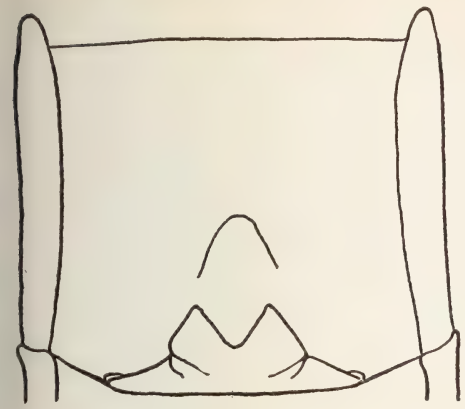
Fig. 3.—*Progomphus alachuensis,* Alachua County, Florida.

Figs. 4-6.—Male abdominal appendages, ventral view.

Fig. 4.—*Progomphus obscurus,* Dexter, Missouri.

Fig. 5.—*Progomphus borealis,* Pima County, Arizona.

Fig. 6.—*Progomphus alachuensis,* Alachua County, Florida.



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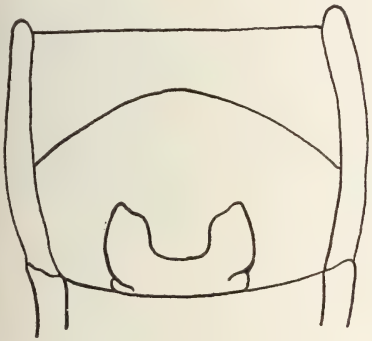

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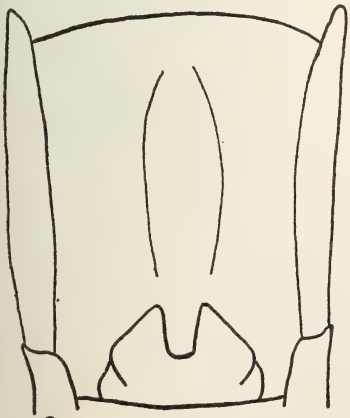

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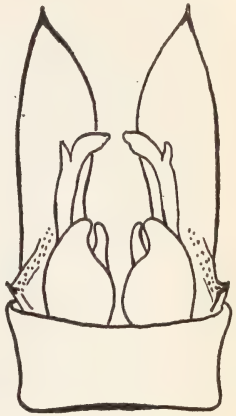

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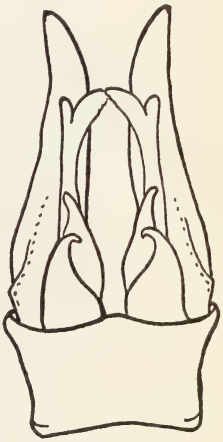

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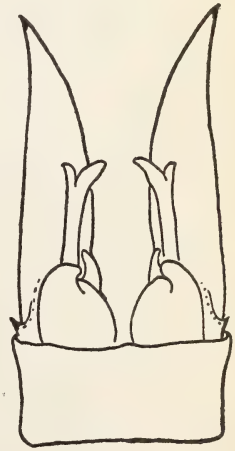

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Plate III

Fig. 1. —Diagram of *Progomphus* thorax (synthorax).

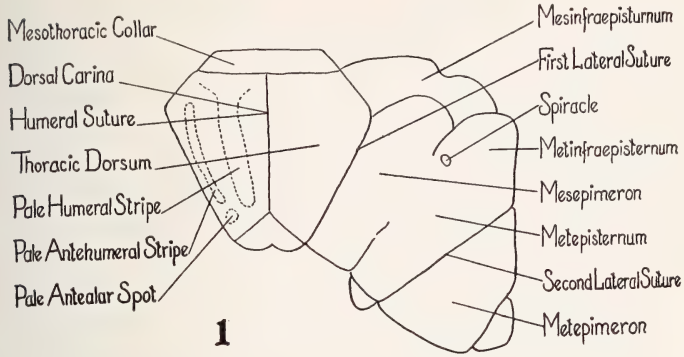
Figs. 2-5.—Thoracic patterns of North American *Progomphus*:

Fig. 2.—*Progomphus alachuensis,* Alachua County, Florida.

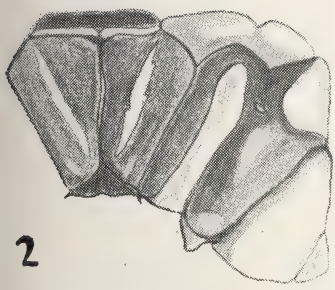
Fig. 3.—*Progomphus obscurus,* Powell County, Kentucky. Light.

Fig. 4.—*Progomphus obscurus,* Dexter, Missouri. Average or normal pattern.

Fig. 5.—*Progomphus borealis,* Pima County, Arizona.


Mesothoracic Collar
Dorsal Carina
Humeral Suture
Thoracic Dorsum
Pale Humeral Stripe
Pale Antehumeral Stripe
Pale Antealar Spot
Mesinfraepisturnum
First Lateral Suture
Spiracle
Metinfraepisternum
Mesepimeron
Metepisternum
Second Lateral Suture
Metepimeron

1



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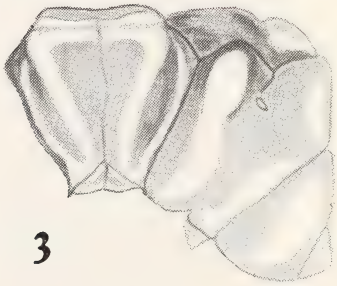

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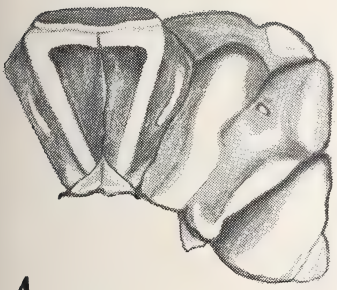

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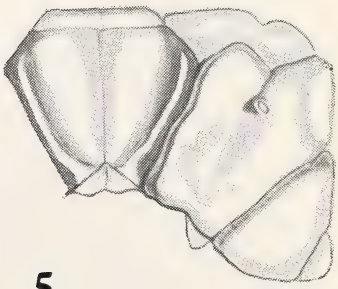

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Plate IV

Figs. 1-8.—Thoracic pattern of South and Central American *Progomphus*. Redrawn mostly from literature as cited.

Fig. 1.—*Progomphus pygmaeus*. Ris (1916:140. Fig. 83).

Fig. 2.—*Progomphus phyllochromus*. Ris (1916:140. Fig. 85).

Fig. 3.—*Progomphus longistigma*. Ris (1916:140. Fig. 79).

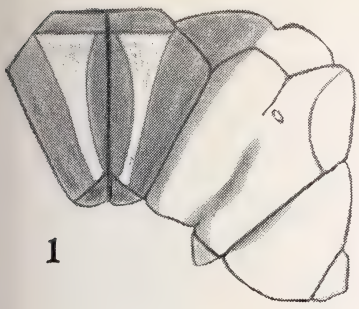
Fig. 4.—*Progomphus gracilis*, ♂. Ris (1911:111. Fig. 7).

Fig. 5.—*Progomphus gracilis*, ♀. Ris (1911:111. Fig. 8).

Fig. 6.—*Progomphus lepidus*, ♂. Ris (1911:112. Fig. 9).

Fig. 7.—*Progomphus sp.*? Williamson (1920a. Pl. I, Fig. 3).

Fig. 8.—*Progomphus risi*, ♂. Williamson (1920a. Pl. I, Fig. 1).



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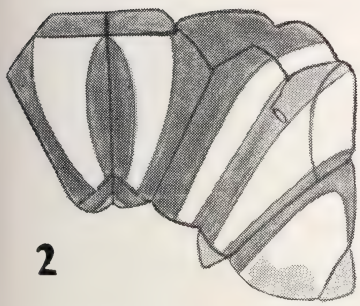

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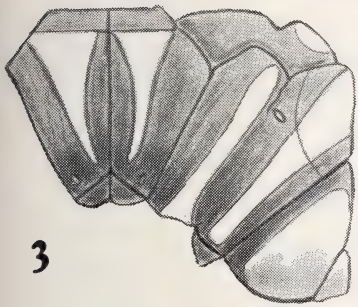

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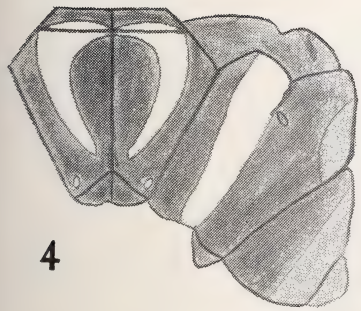

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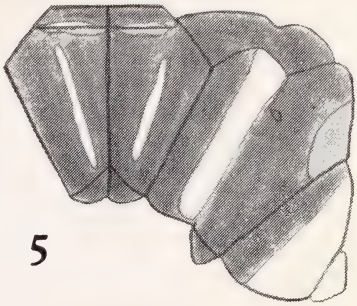

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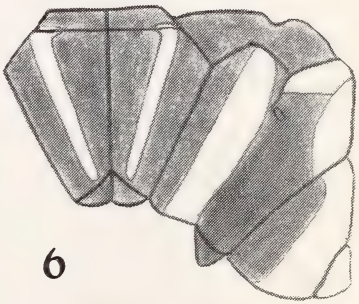

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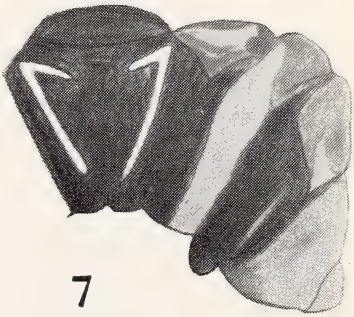

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8

Plate V

Figs. 1-7.—Thoracic pattern of South and Central American *Progomphus*. Redrawn from literature as cited.

Fig. 1.—*Progomphus costalis*. Ris (1911:116. Fig. 16).

Fig. 2.—*Progomphus recurvatus*. Ris. (1911:114. Fig. 13).

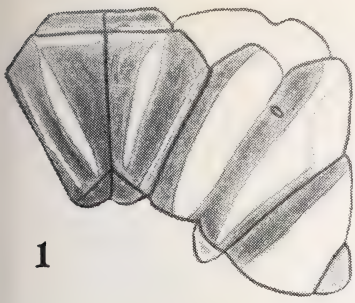
Fig. 3.—*Progomphus basistictus*. Ris (1911:118. Fig. 18).

Fig. 4.—*Progomphus complicatus*. Espirito Santo. Ris (1911:114, Fig. 11).

Fig. 5.—*Progomphus complicatus*, San Bernardino. Ris (1911:114. Fig. 12).

Fig. 6.—*Progomphus auriopictus*. Ris (1911:109. Fig. 4).

Fig. 7.—*Progomphus dorsopallidus*. Byers (1934b. Pl. II, Fig. 1).



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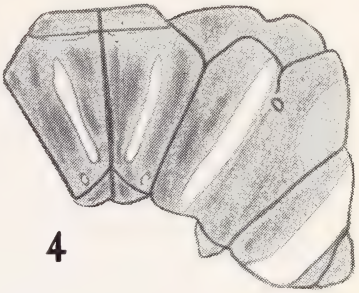

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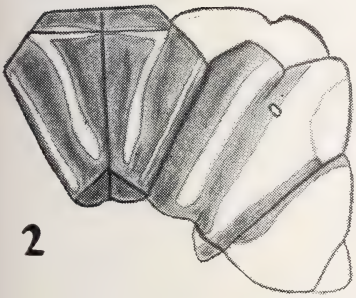

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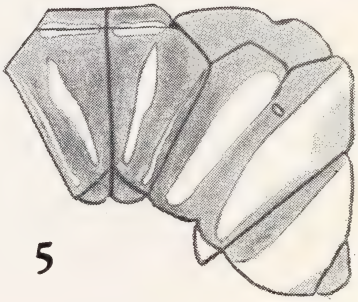

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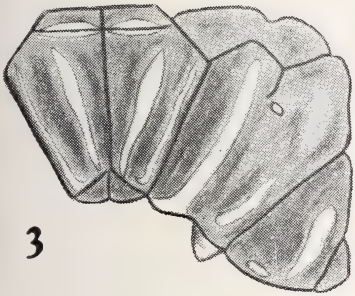

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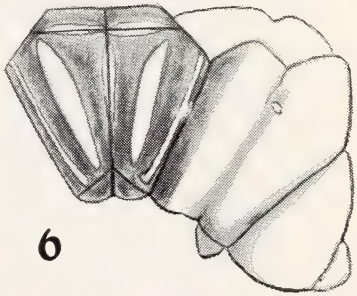

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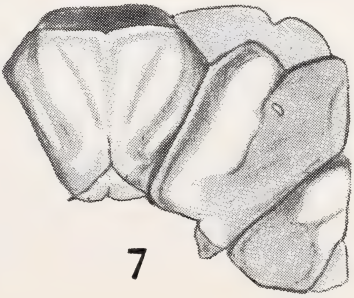

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Plate VI

Figs. 1-2—*Progomphus* habitats in Florida.

Fig. 1.—Newnan's Lake, Alachua County, Florida. Habitat of *Progomphus alachuensis*.

Fig. 2.—Hog Town Creek near Gainesville, Florida. Habitat of *Progomphus obscurus*.

1

2

OUTLINE OF THE GEOLOGICAL HISTORY OF PENINSULAR FLORIDA*

ROBERT B. CAMPBELL
Peninsular Oil and Refining Company, Tampa

French geologists have been making paleogeographic maps since the latter part of the nineteenth century and Charles Schuchert of Yale University has since 1910 made himself the American pontiff of this specialized branch of the science of geology. Such maps have been of great service in the study of intercontinental relationships in the classroom and in the last decade the petroleum geologist has found such maps of much help in his search for new fields. Since the discovery of the East Texas Field the trend in exploration for oil has been in search of buried shore lines, and as structure hunting today is done largely with geophysical instruments, the burden on the geologist is the study of buried conditions in sedimentary basins to give some idea as to source and accumulation beds.

This paper is here presented for the threefold purpose of (1) calling to the attention of the Academy the importance of the Florida area in the interplay of forces between the North American continent and the Antillean region, (2) showing closer control on paleogeographic conditions previously postulated, and (3) presenting data on the subsurface of the state which are as yet unpublished.

Unless otherwise noted the paleontologic information here used comes from Esther Richards Applin of Fort Worth, Texas, who examined cuttings for the Peninsular Oil and Refining Company from its own well and other wells drilled in the area discussed. Appreciation is acknowledged to those operators who furnished well samples for study. The literature used is from the works of Schuchert[1],

*Awarded the Achievement Medal of the Academy for 1939.

[1]Schuchert, Chas., *Historical Geology of the Antillean-Caribbean Region* (New York: John Wiley & Sons, 1935)

Stephenson[2], Cooke and Mossom[3] and others. Schuchert's work on the Antillean Region and Stephenson's on the Gulf Coastal Plain have furnished most of the information from beyond the limits of Florida. Acknowledgment is made of the kindness of Dr. Roy E. Dickerson of Philadelphia and Dr. W. A. Ver Wiebe of the University of Wichita for reading the rough draft of this paper and making some suggestions.

The maps presented are not radical departures from those previously published, but represent a closer control on land and sea limits. Emphatically these maps indicate only the general limits of the seas and should not be regarded as mapping the location of ancient shorelines.

THE GEOLOGIC RECORD

The geologic record in the literature is comprised of various phenomena. The presence of marine, continental, coastal, or estuarine beds, studied with particular attention to lithologic and paleontologic facies and their variation, indicate the distribution of the lands and seas. The presence of unconformities indicates areas where the above evidences may have once been present but now have been removed by erosion. The nature of the unconformity may indicate the nature of the forces removing the sedimentary record.

The record in the well reports is almost entirely confined to the presence or absence of deposits of various ages. Naturally the presence of marine strata of a particular age indicates the former presence of the sea at that point. Its absence might indicate that the sea had never been present there or that the deposits had been later removed by erosion. Here of course the judgment of the paleocartographer is involved.

[2]Stephenson, Lloyd W., "Major Marine Transgressions and Regressions and Structural Features of the Gulf Coastal Plain," *American Journal of Science,* 5th Series, Vol. XVI., No. 94 (1928), pp. 281-298.

———, "Correlation of the Upper Cretaceous or Gulf Series of the Gulf Coastal Plain," *American Journal of Science,* 5th Series, Vol. XVI, No. 96 (1928), pp. 485-496.

———, and Reeside, John B., Jr., "Comparison of Upper Cretaceous Deposits of the Gulf Region and Western Interior Region," *Bulletin American Association of Petroleum Geologists,* Vol. 22, No. 12 (1938), pp. 1629-1638.

———, and Monroe, Watson H., "Stratigraphy of Upper Cretaceous Series in Mississippi and Alabama," *Bulletin American Association of Petroleum Geologists,* Vol. 22, No. 12 (1938), pp. 1639-1657.

[3]Cooke, C. Wythe and Mossom, Stuart, "Geology of Florida," *Florida Geological Survey, Twentieth Annual Report,* (1927-1928), pp. 29-227.

EARTH HISTORY

Thomas Mann in his recent account of Joseph and his circle opens with a philosophic overture which reads, "Very deep is the well of the past. Should we not call it bottomless?" Had his past included the geologic past as did that of H. G. Wells in his famous *Outline* he would have seen that his "well of the past" was over one hundred miles deep, for the post-Proterozoic stratigraphic section has been estimated as 350,000 feet thick[4], and Dana[5] and others have estimated that this represents only about half of geologic time. This section in the "well of the past" is divided into comparative eras, Archeozoic, Paleozoic, Mesozoic, and Cenozoic, with many subdivisions, but avoiding any assignment of absolute age in terms of years. True, attempts have been made to arrive at an absolute age by estimating rates of sedimentation, denudation, or the increasing salinity of the sea[6], but at best they are only springboards for guesses. More recently however, the physicist[7] has furnished a better technique by showing that an absolute age may be arrived at by comparing the amount of helium and lead yielded by uranium, with unaltered uranium. This method of approach has given an approximate age for the oldest known rocks as one billion eight hundred million (1,800,000,000) years. The method has the merit of checking with the comparative method but Fenner[8] has pointed out that errors usually tolerated in analyses made of radioactive material may lead to grievous errors when applied to earth age determinations. A recent textbook gives the following table for such eras:[9]

[4]Field, R. M., "Chronology" in *Van Nostrand's Scientific Encyclopedia* (New York: D. Van Nostrand Company, 1938), p. 263.

[5]Schuchert, Chas., *The Evolution of the Earth* (New Haven: Yale University Press, 1923), pp. 45-81.

[6]Lane, Alfred C., "The Earth's Age by Sodium Accumulation," *American Journal of Science,* 5th Series, Vol. XVII. No. 100 (1929), pp. 342-346.

[7]Kovarik, Alois F., "Basis for Computing the Age of a Radioactive Mineral from the Lead Content," *American Journal of Science,* 5th Series, Vol. XX, No. 116 (1930), pp. 81-100.

[8]Fenner, Clarence N., "The Analytical Determination of Uranium, Thorium and Lead as a Basis for Age-Calculations," *American Journal of Science,* 5th Series, Vol. XVI, No. 95 (1928), pp. 369-381.

Fenner, Clarence N., "Radioactive Minerals from Divina de Uba, Brazil," *American Journal of Science,* 5th series, Vol. XVI, No. 95 (1928), pp. 382-391.

[9]Miller, William J., *An introduction to Historical Geology* (4th ed., New York: D. Van Nostrand, 1937), p. 31.

GEOLOGIC TIME SCALE

Quaternary:	0	to	1,000,000 years ago.
Tertiary:	1,000,000	to	50,000,000 years ago.
Mesozoic:	50,000,000	to	200,000,000 years ago.
Paleozoic:	200,000,000	to	500,000,000 years ago.
Proterozoic:	500,000,000	to	1,000,000,000 years ago.
Archeozoic:	1,000,000,000	to	1,800,000,000 years ago.

But other than permitting the teacher to awe his pupils with the magnitude of the study, and helping the lecturer dull the senses of his hearers so that they are impressed with the futility of questioning later statements, there is little use for this absolute geologic calendar. Happy in realizing that he does not have to squeeze all geologic time into Archibishop Ussher's 4000 years, the geologist returns to his comparative scale.

THE CROSS SECTION

Peninsular Florida's subsurface is best shown in cross section (Fig. 2). It is based on the findings in nine wells (Fig. 1) and shows the subsurface distribution of the geological formations in a north-south direction the length of the Florida peninsula. It should be kept in mind that the diagram is very much foreshortened making the dips appear at much steeper angles than is actually the case. The distortion will be easily understood if it is kept in mind that this north-south distance represents over 500 miles, while the vertical section represents less than 3 miles.

THE WELLS

Adams McCaskill Wells.—In the last year and a half there have been two wells drilled in Pierce County, Georgia, that have revealed much of interest in the study of the subsurface of the southeastern United States. The first was drilled by the Pan-American Production Company on the McCaskill farm. After drilling 600 feet of undifferentiated beds, the Ocala (Eocene) limestone was encountered and persisted to a depth of 2000 feet, where a brown and green marl with Midway fossils occurred.

At 2700 feet was found brown glauconitic shale with Cretaceous fossils continuing to 4000 feet, then succeeded by coarse gray sands whose character suggests Eutaw. The last 30 feet of section, to a total depth of 4370 feet, is described in the samples as pink and grayish altered granite, but reports from the well indicate that the drilling terminated in hard, unweathered granite.

Not satisfied with this the group that had assembled the acreage drilled another well, the Donald Clark No. 1, about three miles

away, apparently in the hope of finding some oil on a postulated shore around this "granite island." The results in general were the same, a similar section being penetrated. The samples saved were taken at 30 foot intervals, so contact points cannot be given with any assurance, but all paleontologists whose reports are available are agreed on the section drilled through—a Tertiary and Upper Cretaceous section normal to the outcrop areas of Georgia and Alabama, underlaid by granite.

St. Mary's River Oil Corporation Well.—At present there is drilling in Nassau County, Florida, a well that has unexpectedly stumbled on a black shale, which, though it shows no fossils, has been tentatively regarded as Pennsylvanian or older by a number of workers who have examined the samples. This well, known as the "Brown well" after the president of the operating company, is located in the northwest corner of Nassau County, a short distance from the Georgia line, and started drilling in a formation mapped as Pleistocene but soon (at 40 feet) went into beds containing *Elphidium gunteri* var., *E. incertum, Rotalia beccarii* var. *parkinsoniani, Bolivina pulchella* var. *primitiva, Nonion cf. depressulum.* This fauna is suggestive of the Choctawhatchee formation of the Upper Miocene. From 400 feet to 500 feet the cuttings showed a granular, cream-colored lime without fossils but tentatively referred to the Tampa. At 500 feet the cuttings revealed the top of the Eocene, with characteristic Ocala fossils appearing for the first time.

The Tertiary formations as seen in the outcrop areas in Georgia are not found in wells on the peninsula of Florida, the entire Eocene here being limestone. In wells the section below the Ocala has two generally accepted divisions, the *Dictyoconus gunteri* zone and an undescribed *Borelis* zone. These formations were found in the Brown well at 945 feet and 2215 feet respectively. The first marks the top of the Middle Eocene and as such might be regarded as the equivalent of the Claiborne and the second considered to represent the combined Wilcox-Midway. It should be kept in mind however that they are equivalents only in that they are in the same part of the geologic section. There is no lithologic or paleontologic correlation, and the names Claiborne, Wilcox and Midway should not be used, at least for the present, in connection with the Eocene formations of peninsular Florida.

The Upper Cretaceous, recognized by the presence of *Lepidorbitoides* and *Camerina cf. dickersoni* (common in the Cuban Cretaceous), was encountered at 2985 feet, and at 3280 feet the bit entered a chalky lime characterized by many *Inoceramus* prisms that apparently represents the Selma chalk of the outcrop area. The Eutaw

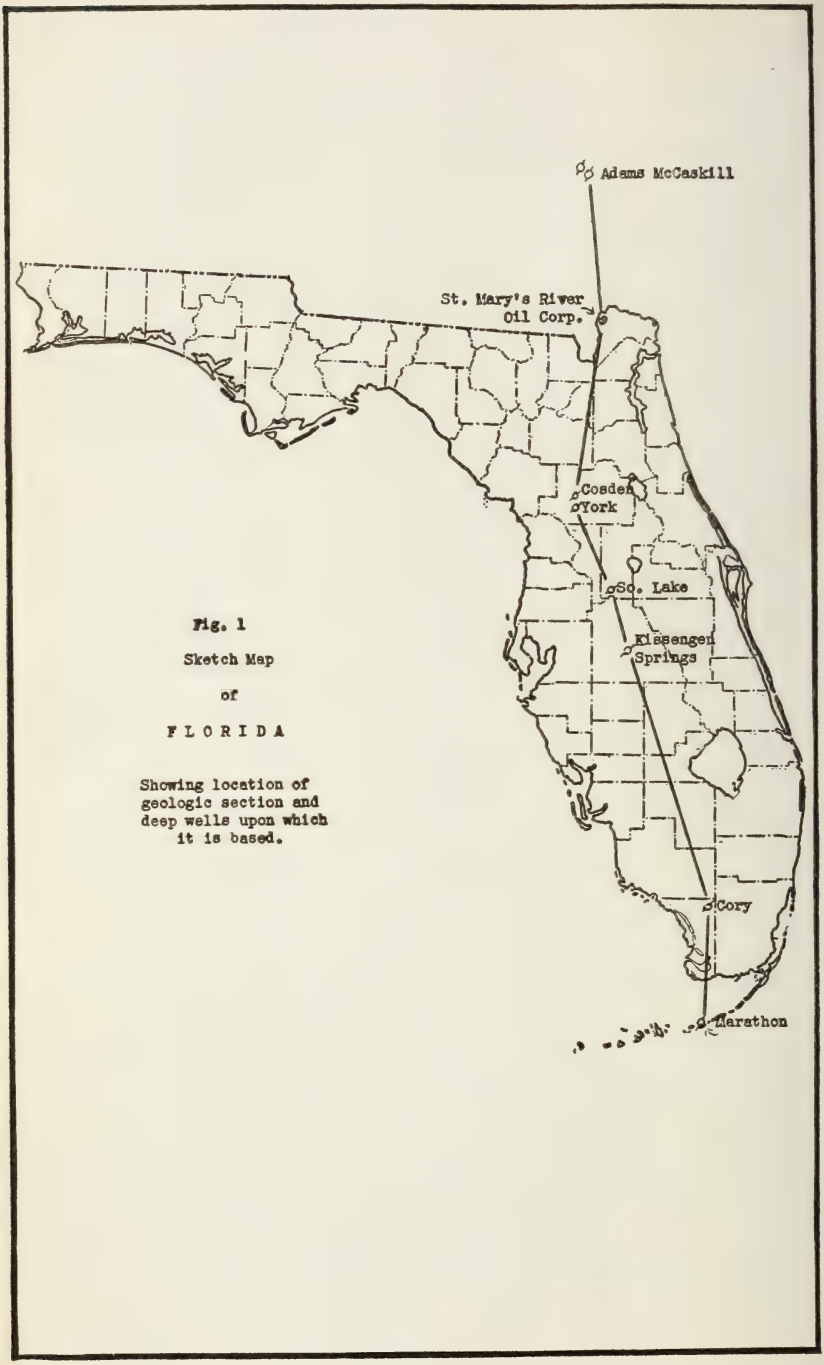

Fig. 1

Sketch Map

of

FLORIDA

Showing location of geologic section and deep wells upon which it is based.

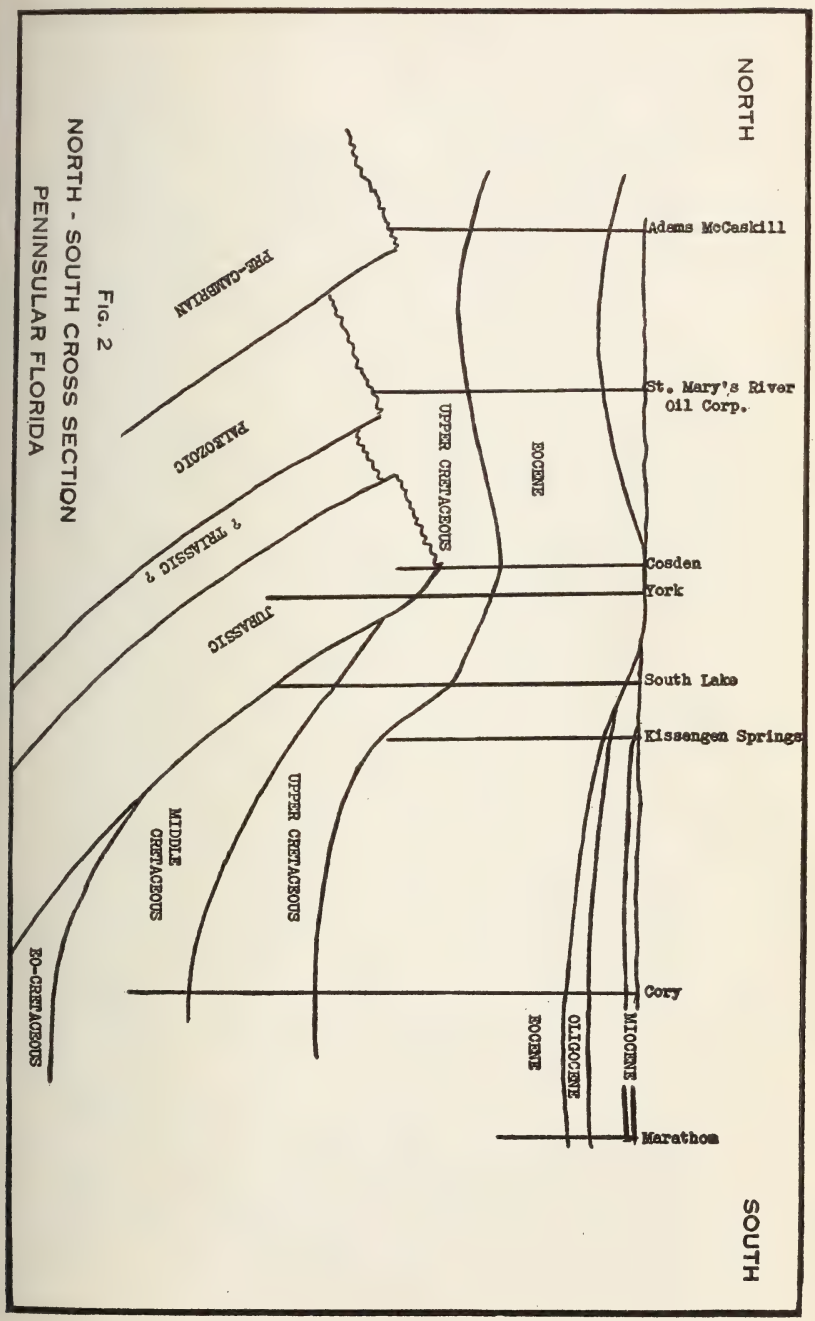

FIG. 2
NORTH - SOUTH CROSS SECTION
PENINSULAR FLORIDA

formation was described at the surface in Alabama on its lithologic character making its recognition in the Florida subsurface difficult, but on a basis of faunal groupings its top has been put in this well at 3748 feet. A non-fossiliferous sandy formation entered at 4547 feet is assigned to the Tuscaloosa, then at 4640 feet the black shale mentioned above was encountered. This has been described as Pennsylvanian or older and a note by the writer appearing in the current *Bulletin of the American Association of Petroleum Geologists* suggests its correlation with the Chattanooga shale (lower Mississipian).[10] There are no contained fossils but the writer thinks that general considerations of paleogeography make it seem the most likely formation of the Paleozoic to be encountered here. The publication of this note should provoke a discussion from which some definite correlation may be determined.[11]

Cosden Well (Sec. 25, T. 3 S., R. 20 E.) *Marion County.*—This well, J. S. Cosden's Lawson No. 1, was drilled in 1928 to a depth of 4434 feet. The Eocene was divided as follows: Ocala 100 feet, Dictyoconus 905 feet, Borelis 1730 feet. The Upper Cretaceous was entered at 2450 feet in beds determined as Maestrichtian in age, and the Tuscaloosa logged at 3570 feet. Mrs. Applin's report considers all beds from that depth to the bottom of the hole as Tuscaloosa but the correlation with the York well ten miles to the south throws some doubt on this. This will be developed after the discussion of the York well.

"The York Well," Ocala Oil Corporation, Clark-Ray-Johnson No. 1, (Sec. 10, T. 16 S., R. 20 E.) *Marion County.*—The York well, despite its incomplete record, is probably the most interesting well yet drilled in the state. The only correlation points available are the Eocene *Dictyoconus* at 920 feet and Borelis zone at 2140 feet. Samples were not furnished throughout the interval where the top of the Upper Cretaceous should have been found but cuttings from formations of that age were found at lower depths. However at 4100 feet schist and quartzite were found and the bit continued in quartzite to a total depth of 6180 feet. The Florida Geological Survey and the United States Geological Survey have tentatively assign-

[10]Campbell, Robert B., "Paleozoic Under Florida?" *American Association of Petroleum Geologists Bulletin,* Vol. 23, No. 11 (November 1930), pp. 1712-13.

[11]More recently Dr. R. S. Bassler of the National Museum has identified some ostracods in this shale as a form close to the genus *Amphissites* and feels confident of the Chattanooga age of the beds.—Written communication from L. W. Stephenson.

ed these basement rocks to the pre-Cambrian because of a similarity to the Piedmont area of the Atlantic Coast States.

A correlation of the Cosden and York wells indicates that both holes terminated in the same formation, but Mrs. Applin refused to accept any "basement" determination for the bottom-most rocks claiming for the Cosden well quartzitic etched sandstone with individual etched, and grains visible, rather than quartzites and micaceous shales rather than schists. In this she was supported by some nationally known petrographers. The writer of the present paper searched the slush pits of both wells and found pieces of cuttings which he called quartzite and on the basis of similar lithology it is here correlated with the Piñar or San Cayetano of Cuba, a formation made up of a series of phyllitic shales and sandstones, the phyllitization varying considerably in short distances, the shales and slightly sericitic shales alternating with the true phyllites. Its sandstones grade into quartzites with individual grains still visible in some coarser varieties. This variation within short distances probably explains the difference in the samples from the Marion County wells. These formations in Cuba have recently been identified by Dickerson[12] as Oxfordian (Upper Jurassic) in age and this determination is by extension applied in this paper to the "basement rocks" under the Ocala Uplift. Dr. Dickerson[13] recognizes the possibility of this correlation.

South Lake Well.—In southern Lake County the Oil Development Company's J. Ray Arnold No. 1 (Sec. 17, T. 24 S., R. 25 W.), carried as inactive in current reports, reached a depth of 6129 feet after penetrating probably all of the Eocene (in which diagnostic fossils were so altered as to render satisfactory subdivision impossible), entering the Upper Cretaceous at 3510 feet and a miliolid limestone, here referred to the Middle Cretaceous, at 5383 feet. At 6050 feet some red clays, gravels and sands were encountered by the bit. Reports were widespread that granite had been found, and some samples circulated as having come from this well were actually found to be granite, but Mr. Arnold[14] denies that his well entered such rocks and quotes some well-known authorities in support of his statement. Mr. Arnold has not yet released his samples but they will be looked for with a great deal of interest as this well is the best sampled

[12]Dickerson, Roy E., "Cuban Jurassic," *Bulletin American Association of Petroleum Geologists,* Vol. XIX. No. 1 (1935), pp. 116-118.

———, "The Lower Cretaceous as a Possible Source of Oil in Cuba," *Mining and Metallurgy,* September 1937, pp. 418-421.

[13]———, Oral communication.

[14]Arnold, J. Ray. Personal communication.

in the state, cores having been taken practically the entire length of the boring. But granite or not, the miliolid limestones at 5383 feet, some beds of anhydrite, and the red sands and gravel are regarded in this paper as representing Middle Cretaceous rocks, and the well is assumed to be in Jurassic at the bottom of the hole. In this connection it might be mentioned that Schuchert regards granites in central Cuba as having been intruded at the end of the Jurassic. Dickerson also notes the association of granite with his Oxfordian.

In this paper the Cretaceous is divided into three parts conforming to the practice in Mexico and here called the Eo-Cretaceous, Middle Cretaceous and Upper Cretaceous. In Texas the division is twofold, Lower (or Comanchean) and Upper Cretaceous, representing the upper two-thirds of the Mexican section. The beds exposed in western Cuba belong to the Lower Cretaceous of Mexico but the miliolid limestones below the Upper Cretaceous chalk in Florida wells are correlated with the Lower Cretaceous of Texas. To avoid confusion the term "Lower Cretaceous" is dropped from this paper and the above subdivision made for Florida's subsurface, namely Eo-Cretaceous, Middle Cretaceous and Upper Cretaceous.

Kissingen Springs Well (Sec. 27, T. 30 S., R. 25E.) *in Polk County.* —The Hecksher-Yarnell No. 1, after drilling several hundred feet of Miocene and Oligocene beds, encountered the Ocala at 275 feet. The interesting feature of this well is its very thick Eocene section, especially in the Borelis zone, to the bottom of the hole at 4540 feet.

Peninsular Oil and Refining Company's Cory No. 1 *in northeastern Monroe County* (Sec. 6, T. 55 S., R. 34 E.)—The Cory No. 1, a dry hole completed May 19th of this year at a total depth of 10,006 feet, is by far the deepest well drilled in the state. The boring commenced in the Pliocene, entered certain Miocene about 500 feet (though some beds above that point were questionably referred to that epoch) and Oligocene at 900 feet. For the Eocene, tops are Ocala 1200 feet, Dictyoconus at 1800 feet and Borelis at 3300 feet. The Upper Cretaceous was encountered about 5700 feet being entirely chalk and chalky lime to 7676 feet where the formations were slightly shaly for a little over 100 feet. About 8000 feet the soft limestone was followed by a harder white lime with alternations of anhydrite and gypsum. The limestone was characterized by many Miliolidae and small fragments of *Gryphaea,* and is correlated with the Fredericksburg division of the Comanchean of Texas. One worker found an isolated *Orbitolina walnutensis* in the bottom-most core correlating the bottom of the hole with the Walnut Clay of Texas.

Lithologically the well may be described as having been in calcareous rocks from the surface to its total depth with the exception of the upper 500 feet where there was considerable white quartz sand and some gravel. The Borelis zone was made up of white and buff lime, chalky lime, dolomite and anhydrite. The anhydrite was confined to the Borelis zone and the Middle Cretaceous. All other rocks consisted of limestone and chalk.

The depths on this well are given in round figures as representing an average of the several reports furnished by various workers. Complete samples have been furnished to the State Geological Survey which will soon publish a detailed description of them by Dr. W. Storrs Cole.

Marathon Well; Monroe County.—The remaining well in this review is the Florida East Coast Railroad Well on Key Vaca, drilled to a total depth of 2555 feet. The record of the geologic section is not very satisfactory but it seems evident that Miocene, Oligocene and Eocene were present to the total depth where the bit was apparently in the Dictyoconus horizon. This division had apparently been encountered at 1850 feet, only slightly lower than in the Cory well.

PALEOGEOGRAPHY

Figure 3 shows the location of nuclear land masses controlling the pattern of sediments in the Southeastern United States and the Gulf region. They are Appalachia, Llanoria, and Antillia. The first has long been recognized as the source of the sediments of the Appalachian Basin to the northwest. Its southeastern border is overlapped by Mesozoic and Cenozoic deposits but Paleozoic there is to be inferred from the paleogeographic maps of the United States that have been previously published. Llanoria was first named by Branner in 1897. Evidences for its postulation were reviewed by Miser[15] in 1921, being essentially that Paleozoic deposits in Central Texas are derived from this area. Antillia, the third area, is confidently mapped by Schuchert and other students of West Indian paleogeography. In the region framed by these nuclear areas the paleogeographic changes of the Florida peninsula are depicted.

Schuchert holds with Suess that the Gulf of Mexico was a "flat-plate" foreland to the Greater Antillean and Central American area. Since the fauna of the Cambrian and Ordovician deposits in the mid-continent contain a Pacific fauna and those of the following Silurian

[15]Miser, H. O., "Llanoria, The Paleozoic Land Area in Louisiana and Eastern Texas," *American Journal of Science*, 5th Series, Vol. 2, pp. 61-89.

contain a fauna characteristic of the Atlantic and eastern South America it seems a fair assumption that sea waters first crossed the "plate" in the area now Florida at that time. Some Lower Mississippian and much Pennsylvanian and Permian occurs in northern Mexico leading to the conclusion that the general invasion by the Paleozoic seas continued appreciably in Lower Carboniferous times. Figure 4 shows how this Late Paleozoic sea covered Florida, the southern limit being according to Schuchert and the northern border drawn to include the Brown well but seaward from the Pierce County (Georgia) wells.

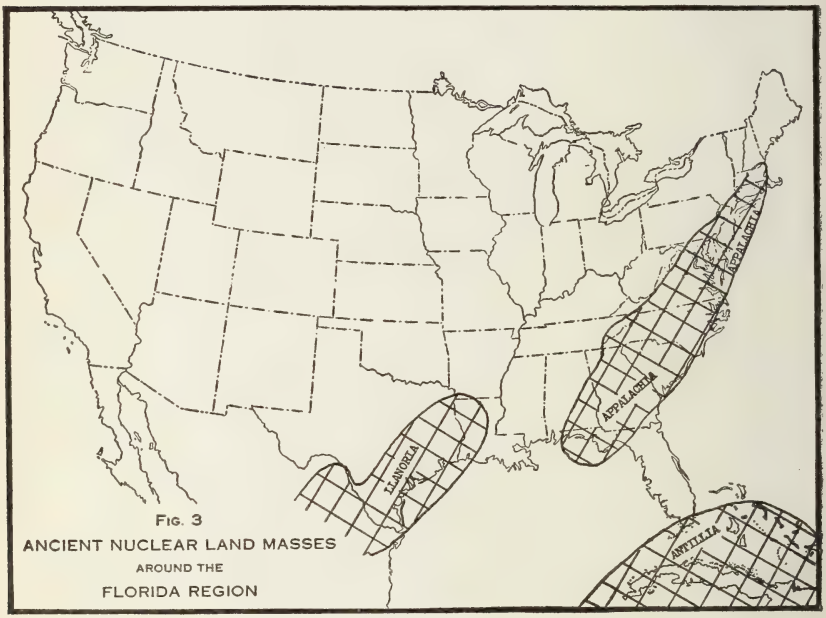

FIG. 3
ANCIENT NUCLEAR LAND MASSES
AROUND THE
FLORIDA REGION

In Mexico there is a marked unconformity occurring after the Permian and as the same exists in the United States it is a safe inference that this marked a period of emergence and erosion in the Florida region.

Triassic: No rocks referable to the Triassic are found in the Florida subsurface, though the cross-section in Figure 2 indicates their position if they should occur. The only marine Triassic mapped in the Gulf of Mexico region is at Zacatecas in Mexico, though continental deposits of that age are mapped in northern Nicaragua, southwest and northern Mexico and in the Atlantic States from North Carolina northward. Recently a well near Clayton, Alabama, reported several hundred feet of arkosic material that has been referred tentatively to the Triassic

by some workers. It seems probable that the Florida peninsula was a land area during Triassic time, marked by the long post-Permian unconformity so widespread in North America.

Jurassic: The Jurassic sea early spread across Mexico northward and in late Jurassic time invaded much of northern Mexico and the eastern part of the Gulf of Mexico. In the western Cuban area the deposits of this age are 400 feet to 1000 feet thick and in the York well at least 2000 feet thick. Figure 5 shows the Jurassic Sea extending over western Cuba and the Florida peninsula to a point south of the Brown well from the log of which rocks of this age are absent. There is no record of a major disturbance at the end of this period in the Mexican region but in California northward there is the record of the Sierra Nevada Revolution, and the total worldwide disturbance at the end of the Jurassic is almost as extensive as that at the end of the Mesozoic. The record of dioastrophism in the Gulf-Caribbean area at the end of the Jurassic is confined to central Cuba and the Isle of Pines, where there are diorite intrusions, but it is likely to have been widespread throughout the whole region.

Eo-Cretaceous: After a long period of emergence and peneplanation the seas again returned to the Gulf region, with deposits of Eo-Cretaceous age now exposed in Mexico and Cuba and found in wells in north Louisiana and south Arkansas as evidence. They are not known anywhere on the Atlantic Coastal plain nor in wells drilled in Florida, but are thought in this paper to have covered the lower part of peninsular Florida as mapped in Figure 6.

Middle Cretaceous: During Middle Cretaceous times the sea spread northward in all the western Gulf area and in southern Arkansas where deposits laid down in this sea are divided into three major groups from below upward, Trinity, Fredericksburg and Washita. The first two are confined to latitudes south of that of the Red River in Texas, but the Washita sea extended in a narrow basin into the Rocky Mountains[16], showing the progressive transgression of the sea northward in the western area. No deposits of this age are mapped at the surface anywhere east of the Mississippi in the Gulf or Atlantic coastal plains. Nor are there any reported from Cuba but gravels in the Upper Cretaceous there are derived from miliolid limestone similar to that of the Middle Cretaceous in Florida's subsurface. The nearby source of those materials may have been either in Cuba or Florida. The map in Figure 7 shows that source to have been in western Cuba. Two

[16]Stanton, T. W., "Lower Cretaceous or Comanche Series," *American Journal of Science,* 5th Series, Vol. XVI, pp. 399-409.

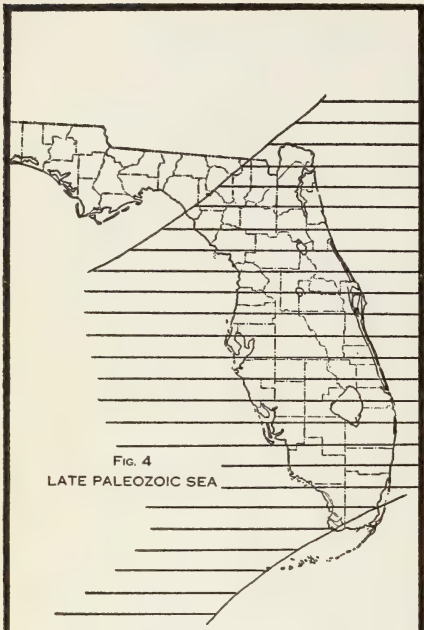

FIG. 4
LATE PALEOZOIC SEA

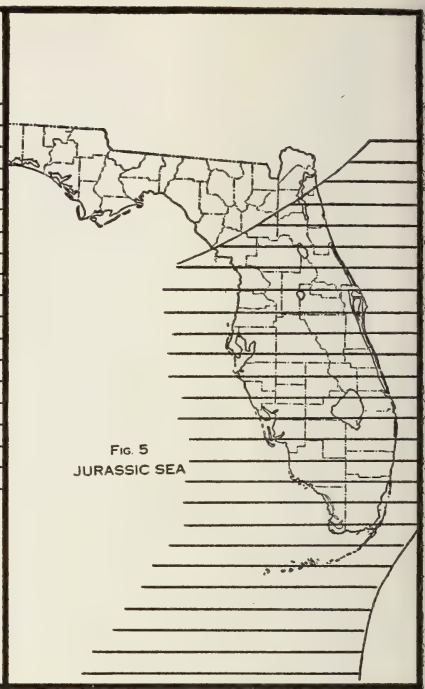

FIG. 5
JURASSIC SEA

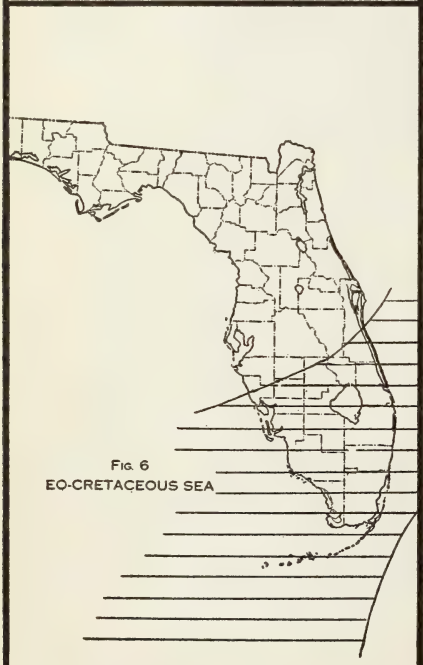

FIG. 6
EO-CRETACEOUS SEA

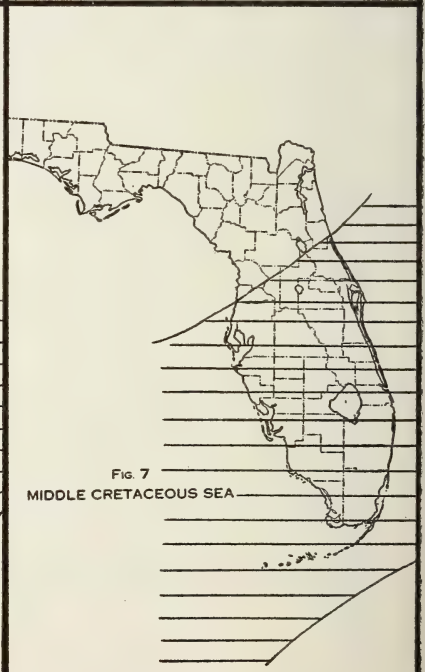

FIG. 7
MIDDLE CRETACEOUS SEA

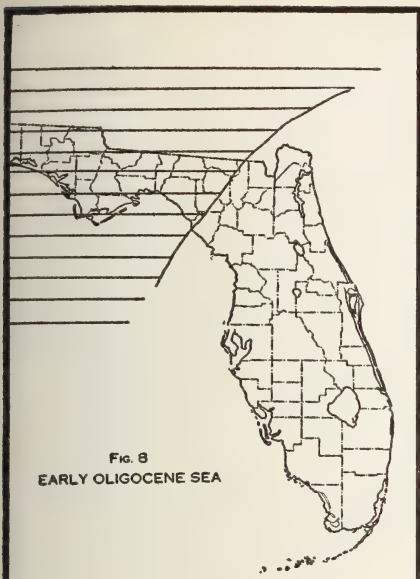

FIG. 8
EARLY OLIGOCENE SEA

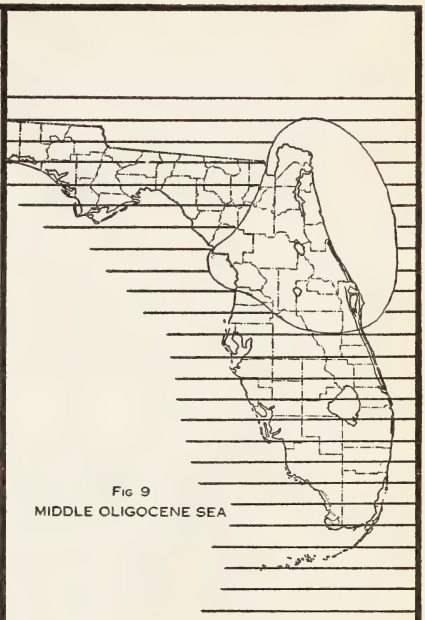

FIG. 9
MIDDLE OLIGOCENE SEA

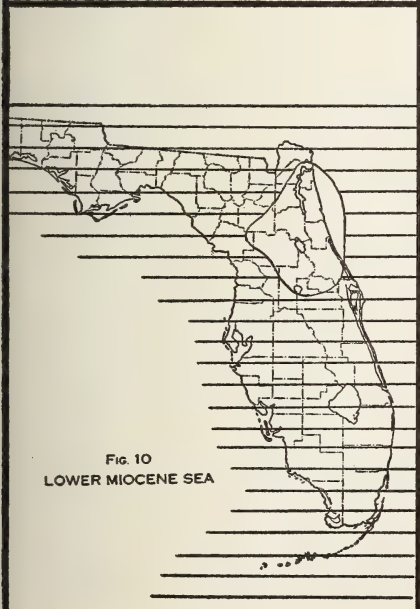

FIG. 10
LOWER MIOCENE SEA

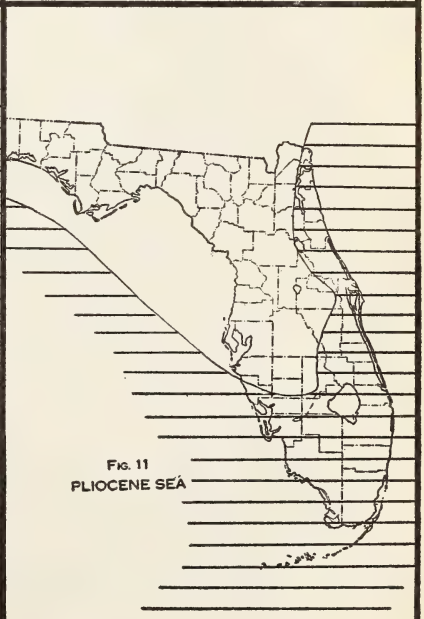

FIG. 11
PLIOCENE SEA

wells in Florida, the South Lake well and Cory No. 1, show deposits of this age, but none are recorded in the York well leading to the mapping of the Middle Cretaceous sea as here shown.

Upper Cretaceous: The Middle Cretaceous was followed by an erosion period long enough to reduce the land surface to an approximate peneplain, but soon the sea again encroached on the land and extended over most of the Antillean region in the Mississippi valley as far north as the southern tip of Illinois, and up the Atlantic coast to southeastern Massachusetts. D. W. Johnson[17] even thinks it once covered the Appalachians. At any rate it covered all of the Florida area, for a full section has been penetrated by all wells in the state drilled deep enough. With no land area showing no map is necessary here.

Eocene: There is a world-wide hiatus marked everywhere by erosional unconformities at the surface indicating the extensive retreat of the sea between Upper Cretaceous and Eocene time, and in Cuba and Hispaniola it even continued until middle Eocene. Such a hiatus is not apparent, however, at the bottom of the Eocene in Florida, and in the deepest wells the paleontologist may find some answer to Stephenson's[18] question, "May we not some day find marine deposits intermediate between the Cretaceous and the Eocene?" Some of the paleontologists working on the samples from the lower several hundred feet of the Eocene in the Cory well had difficulty with this part of the section.

The Eocene strand line, (a palm fringed shore, for Berry[19] reports fossil palm wood from the Eocene of Georgia and a palm nut from the Ocala in Florida) extended well north into Georgia, and since this sea covered all of Florida no special map is prepared here.

Oligocene: During early Oligocene time most of Florida was emergent as was the Greater Antilles. The entire Antillean area may have been one great island or even the extension of a peninsula from Central America. Figure 8 shows how the area was cut off from continental

[17]Miller, William J., *Introduction to Historical Geology* (4th ed.; New York: D. Van Nostrand, 1937), p. 263.

[18]Stephenson, Lloyd W., "Major Marine Transgressions and Regressions and Structural Features of the Gulf Coastal Plain," *American Journal of Science,* 5th Series, Vol. XVI, No. 94 (1928), pp. 281-298.

[19]Berry, E. W., "A Palm Nut of Attalea from the Upper Eocene of Florida," *Florida Geological Survey, 21st-22nd Annual Report* (1930), pp. 123-125.

North America by narrow straits extending from the Gulf to the Atlantic.

Later, in Middle Oligocene times, however, Florida and Cuba again subsided, leaving the largest emergent islands at Hispaniola and in Florida in the northeast part of the state as shown in Figure 9.

Miocene: Continuing from Upper Oligocene time, Lower Miocene was a time of continued subsidence when an island remained as shown in Figure 10, similar to but of less extent than in Oligocene time. According to Mansfield[20] western Florida at this time was a wide embayment whose waters entered from the south, with the sediments of the Tampa limestone being deposited in a shallow sea. In the Tampa area Dall[21] reported 24 fresh water species in addition to nearly 300 marine and brackish water species, and near Orient Station, east of Tampa, the sediments present a sandy facies. All these point to a shallow water area with probable nearby islands. Dickerson[22] suggests this picture might be reinforced by a detailed working out of Dall's description of the Tampa fauna. Dickerson says, "The Tampa formation of Lower Miocene age contains a land shell fauna of Cuban affinities. This suggests that the Florida islands of Lower Miocene age possibly stood on the same platform with Cuba and were loosely connected from time to time. It is hardly conceivable that all of the species described by Dall could have reached Tampa vicinity in accidental drifts, i. e., waifs." Dall's original work has not been available for the preparation of the present paper so this welcome additional reference strengthens the account here given. Since the island or islands above water during middle and later Oligocene and Miocene time would show a land fauna whose ancestral genera were widespread over the earlier Oligocene island mapped, islands representing the topography of this earlier large island would be refuges for a land fauna fleeing the encroaching sea. Each such fauna would of course show an affinity for that of other islands of the same antecedents. Much valuable work has been done and is at present being pursued on the Miocene fauna of this state and perhaps this together with a detailed investigation of the clastic materials in the Tampa formation and their source will one day make it possible to map the several or numerous islands existing during this time.

[20]Mansfield, W. C., "Molluscs of the Tampa and Suwannee Limestones of Florida," *Florida Geological Bulletin*. No. 15 (1937), p. 38.

[21]Cooke, C. Wythe and Mossom, Stuart, "Geology of Florida," *Florida Geological Survey, Twentieth Annual Report* (1927-1928), pp. 29-271.

[22]Dickerson, Roy E., Letter of November 10, 1939.

The extent of the island mapped through Oligocene and Tampa time is shown by Stubbs'[23] work in the Sanford area where thinned Ocala and pre-Ocala limestones lie immediately under the Hawthorne phosphatic limestone. This is interpreted here to mean that the uppermost Eocene rocks were undergoing erosion during all of Oligocene and early Miocene time, removing nearly all of the Ocala rocks before the encroachment of the Hawthorne sea.

Tampa time may have been followed by a brief uplift but if so it was almost immediately followed by a return of the sea during which time the Alum Bluff and Hawthorne formations were laid down. During this time, according to Gardner,[24] the sea was at first warm (since the contained fauna is of tropical shallow water types) but as it retreated the waters became colder but not rigorous. The sea's recession, marked by later Alum Bluff (Oak Grove and Shoal River) and Choctawhatchee time, continued until Pliocene time.

Pliocene: The emerging land mass indicated as having occurred during later Miocene time, in Pliocene time became a peninsula forecasting the shape of the state today as shown in Figure 11. This figure shows the area where Mansfield[25] has recently named the Buckingham limestone as a prototype of the present day keys. The geologic map of Florida shows four formations of Pliocene age in the Florida peninsula; Caloosahatchee, Alachua, Bone Valley and Citronelle. The first indicates the Pliocene sea area, the second its land area in part, the third the delta area on its southwestern shore, and the fourth the Citronelle river and beach sands derived from continental North America. It is possible that some of these Citronelle beds in the west should be mapped as sea areas but in that case only the size but not the shape of our Pliocene peninsula would be altered.

Pleistocene: During Pleistocene time Florida, according to Cooke,[26] was the scene of a number of fluctuations of sea level controlled by "the alternate accumulation and melting of vast polar and sub-polar ice

[23]Stubbs, Sidney A., "A Study of the Artesian Water Supply of Seminole County, Florida," These *Proceedings,* Vol. 2 (1937), pp. 24-36.

[24]Gardner, Julia, "The Molluscan Fauna of the Alum Bluff Group of Florida," *U. S. G. S. Professional Paper* 142-A, (1926), p. 2.

[25]Mansfield, W. C., "Notes on the Upper Tertiary and Pleistocene Mollusks of Peninsular Florida," *Florida Geological Survey Bulletin* No. 18, (1939), p. 8.

[26]Cooke, C. Wythe, "Scenery of Florida interpreted by a Geologist," *Florida Geological Survey Bulletin* No. 17, (1939), pp. 33-68.

caps." He maps six such changes but of course does not mean that these are all that occurred. During the time of these fluctuating seas numerous sand terraces were deposited over Florida and a fringe of sands, öolites, and coquina added to the peninsula at that time. Cooke thinks his study shows no tilting of the Florida platform since that time. This view is not shared by the present writer.

Recent: Since Pleistocene time the state has had essentially its present shape with several features indicating that the east coast is at present rising and the west subsiding. Some of these features are, the wave-cut cliffs between downtown Miami and Dinner Key, the drowned rivers at Charlotte Harbor and the Caloosathatchee, the drowned lake represented by Tampa Bay, the increased gradient to the west indicated by the Hillsborough River's piracy of its neighbors, and the drowned drainage of the entire west coast from Anclote Keys to Apalachee Bay. This last feature is frequently noted by passengers on the commercial airline from Tallahassee to Tampa.

This tilting may be caused by the sedimentary load subsidence of the northwestern Gulf area described by Barton, Ritz and Hickey,[27] where geologic and geophysical data indicate the presence of a geosyncline comparable with the Appalachian. That area has been one of continued subsidence the rate of which has kept pace with that of sedimentation.

SUMMARY

The Florida peninsular area throughout most of its geologic history has been submerged and as such, has been the connecting link from the Gulf of Mexico to the Atlantic, between the nuclear land masses of Appalachia and Antillea, roughly represented today by the Piedmont area of the southern states and the Greater Antilles respectively. The only time it was completely emerged from the sea was during Lower Oligocene time when it was cut off from the North American continent by narrow straits, and only since the beginning of the Pliocene epoch has this area been part of North America and separated from the Antilles.

At least since Eocene time this area has tended to tilt to the west, the cause suggested being the influence of the subsidence of the "Barton" syncline in southern Louisiana.

[27]Barton, D. C., Ritz, C. H. and Hickey, Maude, "Gulf Coast Geosyncline," *Bulletin American Association of Petroleum Geologists,* No. 17, (1933), pp. 1446-1458.

ADDENDA TO THE LIST OF BIRDS OF ALACHUA COUNTY, FLORIDA

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At the suggestion of Mr. Robert C. McClanahan, formerly connected with the Biology Department at the University of Florida, the author has endeavored to bring up to date the list of birds that have been observed in Alachua County, Florida.[1] Since Mr. McClanahan's departure from the University of Florida, observations have been carried on to a limited degree, and it is the author's hope that these addenda will mark the beginning of concentrated field work to be published each year as new records concerning distribution and migration are obtained. There are still many species that are as yet unrecorded for the county which there is every reason to believe occur here.

There is one noteworthy additional fall migration record to be added at this time:

Lesser Yellowlegs—*Totanus flavipes* (Gmelin) A. O. U. 225. This constitutes the first fall record for this species. Mr. Charles E. Mounts reports two records, one in the fall of 1937 at Bivan's Arm, and one October 28, 1939 at Sugarfoot Prairie.

NEW RECORDS

202. Blue Goose.—*Chen caerulescens* (Linnaeus) A. O. U. 169.1. One was seen by Mr. Jack C. Russell on Bivan's Arm January 26 and 27, 1939.

203. Short-Billed Marsh Wren.—*Cistothorus stellaris* (Naumann) A. O. U. 724. I collected one specimen of this species at Lake Alice, September 27, 1939. The specimen is in the collection of Mr. Charles E. Doe at the P. K. Yonge Laboratory School, University of Florida.

204. Long-Billed Marsh Wren.—*Telmatodytes palustris* subsp. It is impossible to determine the subspecies of the long-billed marsh wren in the field; however, I have observed the species several times in the marsh bordering Lake Alice. The first record was obtained on October 3, 1939 by Mr. Alphonse Chable and myself.

[1]McClanahan, Robert C., "Annotated List of the Birds of Alachua County, Florida," these *Proceedings*, Vol. 1 (1936), pp. 91-102.

205. Black-throated Green Warbler.—*Dendroica virens virens* (Gmelin) A. O. U. 667. One positive sight record of an adult male was made by Mr. Jack C. Russell in the fall of 1937.

206. Florida Pine Warbler.—*Dendroica pinus florida* (Maynard) A. O. U. 671a. Several sight records have been made by Mr. Charles E. Doe, and Mr. Jack C. Russell banded one in the fall of 1937.

207. Mourning Warbler.—*Oporornis philadelphia* (Wilson) A. O. U. 679. One reasonably good sight record was made at Hatchet Creek by Mr. George Bentley and Mr. Charles E. Mounts, November 11, 1939.

NOTES ON THE BREEDING HABITS OF THE WARMOUTH BASS

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Despite the considerable importance of the warmouth bass (*Chaenobryttus gulosus*) from the standpoint of the southern earthworm angler, little information concerning its habits and life history has been recorded. Hubbs[1] described a nest of this species which he found in a park lagoon in Chicago, and scattered miscellaneous observations have appeared elsewhere, but few of the more important points in the breeding and nesting behavior are to be found in the voluminous literature of sunfish habits.

During the past spring I have had the opportunity of observing a colony of breeding warmouths throughout their period of nesting activity. The colony was located along the northern shore of a marshy lake, Biven's Arm of Payne's Prairie, two miles south of Gainesville, Florida, where the warmouth is a relatively abundant member of a sunfish fauna which includes *Huro salmoides, Helioperca macrochira, Pomoxis sparoides and Sclerotis p. punctatus.* The period of active aggregate nesting extended from March 14 to April 1, although occasional nests were encountered sporadically throughout the ensuing month. Water temperatures ranging from 13° to 22° C. were found during the breeding period.

THE NESTING SITE

The colony kept under observation was the only one which I was able to locate anywhere along the shoreline, and it seems quite likely that it represented a large percentage of the breeding population of the lake. The nesting site was a strip of some fifty yards of fluctuating shore zone where frequent changes in water-level had reduced the hydrophytic vegetation to a minimum, and numerous patches of open water occurred. The water-level was relatively high at the time of the study and the bases of the maple and wax-myrtle trees lining the shore were inundated. Aquatic vegetation in this area consisted of scattered clumps of button-bush and maidencane and an occasional luxuriant bed of *Callitriche.* The white sand bottom was covered with

[1]Hubbs, C. L., "The nesting habits of certain sunfishes as observed in a park lagoon in Chicago," *Aquatic Life,* Vol. 4, No. 11, (1919), p. 143.

a layer of fine organic silt mixed with twigs and leaves from overhanging trees. This accumulation of debris varied between one and five inches in depth. Since the bottom along much of the remainder of the lakeshore was covered with flocculent ooze to a depth of ten inches or more it seems probable that the selecting of this particular area by the fish was due more to the nature of the bottom deposit than to any other factor.

At the peak of breeding activity about one hundred nests were in use by the fish. Since many of the nests were built and abandoned before being put to use and many others occupied by several successive tenants, there is no way of estimating the number of fish breeding in the area.

THE NESTS

Forty nests were marked in an early stage of construction and were observed daily throughout the period of the study. As in all other species of sunfish whose habits have been recorded, the nest is constructed by the male, which in typical sunfish fashion excavates the cavity with sweeping motions of the caudal and pectoral fins. Most of the nests were built in from two to ten inches of water and from one to twelve feet from shore. No nest was found in water over fourteen inches in depth.

The nests were exceedingly heterogeneous in size and conformation. Those constructed in open water were mostly six to eight inches in diameter, and were excavated to a depth of from one to five inches, depending upon the depth of the layer of leaf-mold and silt. Thirty-five percent of all nests observed were constructed in close proximity to some object, such as the base of a tree, an exposed root or sunken stick, or a clump of buttonbush or emergent herbs. Where the layer of detritus was shallow, the bottom of the excavation reached the underlying sand and the expelled trash was piled in an elevated rampart around the depression. Some of the nests were merely cavities in the silt, while those built near tussocks of grass or rushes were often filled with fibrous root masses which the fish usually nibbled clean of bark.

One small fish built a most unusual nest in a very dense bed of *Callitriche*. Pushing his way into the center of the bed, he chewed off and beat down stems and leaves until a nearly spherical chamber of four and a half inches in diameter had been formed. Although this cavity was too small to accommodate the fish comfortably it was never enlarged, and the guardian male remained in it throughout the nesting period with his body slightly bent.

On open bottom the nests in the more thickly settled sections were usually from two to three feet apart, but where screened from one another by emergent vegetation they were often separated by a distance of no more than three or four inches; in one instance fish excavated and occupied confluent cavities.

THE MALE AS A PARENT

On completing construction of the nests the males took up their positions in or near their excavations to await the advent of females. At this time the fish were brilliantly colored, the eye, in most individuals being bright red, the longitudinal opercular streaks iridescent, metallic blue and the vertical bars on the body were very dark and distinct.

In most cases eggs were to be found in the nests within twelve hours after their completion, but a few of the fish guarded empty nests for twenty-four or even thirty-six hours before mating occurred.

During courtship and mating the fish of both sexes were excessively shy, and since most of the process took place in water no more than a foot deep, a close approach was impossible. However, fragmentary observations at this time indicated that the mating behavior was not essentially different from that of the large-mouth bass and other centrarchids.

After deposition of the eggs, and throughout the larval life of the offspring, the males apparently never left the nests except to pursue other fish which approached too closely, or when frightened by the observer.

Many of the fish allowed me to approach the nest within a few inches without taking alarm. When frightened away from his post a fish would usually take up a protected position in nearby cover and regard the nest and intruder anxiously. On such occasions several individuals rushed back into the nest and out again, nearly knocking from my hand the pipette with which I was taking specimens of eggs or larvae.

A nest left unprotected was nearly always immediately invaded by hosts of cyprinodont minnows, chiefly *Gambusia affinis holbrookii, Chriopeops goodei* and *Fundulus chrysotus*, which attacked the eggs or helpless larvae greedily. Often, when I stood directly over such a violated nest, the parent warmouth would dash between my feet and, pivoting abruptly among the rapacious minnows, knock many of them out of the water.

Previous studies of the nesting habits of sunfish indicate that in certain species the nests are left unguarded during the night. Breder[2] says that even the passing of a cloud over the sun will often cause

a parent to leave its duties. The warmouth male, however, remains on the nest at night, and is, in fact, more stubbornly disinclined to leave it than during the day. I found that in the light of a flashlight many of the nesting males would permit themselves to be touched, and even handled gently, without taking flight, although they often butted and bit at the offending fingers.

Although the males apparently did not leave the nests to forage they took food readily when it came within reach. Small frogs, grasshoppers, earthworms and freshwater shrimp which I threw to fish on guard were nearly always eaten. Four fish which I caught with bent pin hooks were taken to a point at shore twenty feet from their grouped nests, were laid on wet grass while the hook was being removed, and were then allowed to flop back into the water. One of these swam directly to his nest, took up his position on it, and began fanning the fry. Of the remaining three fish, two had returned to their duties within an hour and one abandoned his nest permanently.

THE EGGS AND LARVAE

Oviposition in the warmouth apparently may take place throughout the day, but rarely, if ever, at night. The freshly deposited eggs which I examined were from 1.0 to 1.1 mm. in diameter, and of a clear amber color. The eggs were adhesive and, in nests where the bottom was clear of fibrous material, usually stuck together in small clusters. In the root-mass nests, however, the eggs assumed a linear, bead-like arrangement along the frayed rootlets. The incubation period was found to vary between 25 and 45 hours. It is probable that the shorter period approaches the normal average more closely, since the longer periods represented complements whose development was undoubtedly retarded by a drop to 13° C. in water temperature.

While the eggs were incubating, the male fanned continually, and kept the nest clean of all trash and slit, but after hatching, the larvae were kept partially covered with debris swept in from around the sides of the nest. Thus, a nest containing eggs was readily distinguished from one containing larvae, the white sand being exposed in the center of the nest in the former case, and around its periphery in the latter.

At the time of hatching the larvae were from 2.8 to 3.1 mm. in length. They lay on their sides on the bottom of the nest until about five days after hatching, at which time the swim-bladder presumably

[2]Breder, C. M., "The reproductive habits of the North American sunfishes (Family Centrachidae)," *Zoologica,* Vol. 1 (1936), p. 3.

attained a functional stage of development, since the larvae began assuming the upright position and making awkward, spasmodic dashes about the bottom of the nest or up into the overlying water. Seven days after hatching they were usually capable of sustained swimming, and at an age of ten days and a length of from 5.5 to 6.0 mm. abandoned the nest. At this time the male also usually quit his post.

The free-swimming post-larvae apparently dispersed throughout beds of submerged and emergent vegetation and were never found in schools such as are characteristic of the fry of other species of sunfish.

ENEMIES

Several species of fish took advantage of every opportunity to devour the eggs and larvae. In addition to the species named above, the blue-gill bream (*Helioperca macrochira*), the golden shiner (*Notemigonus c. bosci*) and the star-headed minnow (*Fundulus n. lineolatus*) were also seen pillaging unguarded nests regularly. Several other organisms, which were found in nests on one or more occasions, and whose importance as factors in the ecology of the nesting warmouth is unknown, are listed below.

Freshwater shrimp (*Palaemonetes sp.*); one seen on bottom of nest among eggs; the fish returned as I watched and ate the shrimp.

Aquatic mite (*Diplodontus despiciens*); very numerous in many nests for a short while after eggs had been laid.

Aquatic Hemiptera; one *Belostoma sp.* swam into nest and was butted out by fish; two *Benacus* sp. swam into nests and were driven out by warmouths.

Aquatic beetles; a single *Sybister* sp. swam into a temporarily abandoned nest, nosed about briefly among the eggs, and retreated; one or more species of haliplids were found in several nests.

Molluscs; a snail, *Physa* sp., and a pelecypod, *Pisidium* sp. were found commonly.

A mud eel (*Siren lacertina*), some twelve inches in length, was found coiled in the bottom of a nest which, for an unknown reason, had been abandoned on the preceding day.

A banded watersnake (*Natrix s. pictiventris*) was seen at night with its head thrust into a nest from the surrounding dense vegetation. The warmouth was fanning, and evidently unaware of the snake's presence. The snake touched its tongue lightly against the side of the fish in several spots, apparently in the attempt to guage the size of a potential mouthful, but eventally withdrew without striking.

A DIAGNOSTIC TAXONOMIC CONSTANT FOR SEPARATING SLASH AND LONGLEAF PINES

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An ever-present problem confronting amateur botanists, laymen and research workers in fields allied to botany is that of identifying two of our more important pines namely, long-leaf pine (*Pinus palustris Mill.*) and slash pine *(Pinus caribaea Mor.)*. The objective of this study was to find a diagnostic character that any one could use and one that was present at all seasons of the year. The one character that fulfills these two requirements is length of fascicle sheath. The relative merits of this character will be discussed from both a taxonomic and an ecological viewpoint.

A review of the literature and existing books on trees of the southeastern United States shows that this is a character, as yet, not included. The results of the study show conclusively that such a constant as fascicle sheath length is worthy of a prominent place in any key to pines of the southeast involving these two species.

METHODS AND PROCEDURE

Needle samples were obtained from all coastal states from North Carolina to Texas and these were further augmented by samples from sixteen counties within the state of Florida in which either or both of the species occurred.

The procedure followed in obtaining and measuring samples was as follows: (1) to obtain needles from naturally-grown as well as planted trees, (2) to include as many varied age classes as possible, (3) to secure ten fascicles from ten trees for each locality and species sampled, (4) to compare sheath measurements on fascicles taken from various positions on the tree, (5) to compare sheath measurements made on green needles with similar measurements on dead needles found on the ground, (6) to measure sheaths on herbarium mounts, (7) to take measurements on all fascicles regardless of needle length and (8) to compare fascicle measurements under varying conditions of environment.

DEFINITION OF TERMS

A fascicle is a cluster of needles as it would drop from a branch and is made up of the green needle-like leaves and the sheath. The sheath is that membrane enclosing the base of the needles and in-

tact over its entire length without evidence of fraying. A mature sheath at the end of one year will produce a fringe terminating the sheath. The sheath measurements apply only to that portion of the sheath that shows no evidence of fraying.

RESULTS OF THE STUDY

Stating the results of the study in general terms, a sheath greater than .5 in length would characterize the species as longleaf pine whereas a sheath less than .5 in. long would be characteristic of the slash pine. The data show that slash sheaths reach a maximum length of .5 in. and a minimum of .3 in. The average of all slash data is .39 in. A statistical analysis of these data shows a standard deviation of $\pm$ .07 in., based upon 1412 measurements from 249 individual trees.

An analysis of the longleaf data shows a maximum sheath length of 1.5 in. and a minimum of .6 in. The average sheath length, based upon 1390 separate measurements from 252 trees, was found to be .88 in. The standard deviation of these data was $\pm$ .10 in.

A comparison of the maximum sheath length of slash and the minimum length of longleaf pine shows a marginal difference of .1 in. or about 3 mm. This difference is highly significant in that it can easily be detected by eye or by use of a ruler. There were very few instances throughout the study where a ruler was necessary to separate the two species. Of the longleaf data only 16.8% of the measurements were less than .7 in. With reference to the slash data only 15.7% of the sheath measurements were as great as .5 in.

An ecological analysis of the data was made to determine whether or not environmental conditions played an important part in causing long or short sheaths. The factors taken into consideration were climate, soil type, previous fire history, habitat, age, season of the year when the needles were collected and age of the fascicle and sheath. This latter factor, age of fascicle sheath, was the only one found definitely to influence sheath length. Sheaths measured on fascicles taken in the spring of the year after new needles had been produced were extremely long for both species. This was due to the immature stage of the sheath. The normal sheath fringe is not fully developed until the fall of the year when this diagnostic character becomes applicable. Therefore, in using sheath length for separating slash from longleaf pine, needles not less than six months old, or better still one year old, should be used if taken from the tree in a green condition. The age of a fascicle can easily be determined from the color of the sheath. An immature sheath will have a smooth

surface and be light yellow in color, whereas a sheath one year old will be somewhat wrinkled, weathered, and slate gray in color.

The above mentioned environmental conditions, other than age of sheath, had no effect on sheath length. Therefore, it was concluded that slash and longleaf pines can be separated taxonomically using this character at any time of the year, on any fascicle of needles living or dead, by visual means and it is not necessary to have or to rely on cones, flowers or needle length for a correct identification.

THE VAPOR PHASE OXIDATION OF ALPHA PINENE

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Many attempts have been made to oxidize naturally occurring hydrocarbons, such as petroleum derivatives, benzene, naphthalene and the like, directly to more valuable oxygenated compounds, using air as the oxidizing agent and using catalysts to control the reaction. Whereas in the case of aliphatic hydrocarbons (usually from petroleum) only moderate success has been achieved, application of such oxidations to aromatic hydrocarbons has resulted in the development of several highly successful commercial processes. As most notable among these may be cited the production of phthalic anhydride from naphthalene and the production of maleic anhydride from benzene. Other examples of the commercial application of the process include the production of both benzaldehyde and benzoic acid from toluene, anthraquinone from anthracene, various aldehydes and acids from the xylenes, and so on.[1]

The vapor phase oxidation of organic compounds is carried out essentially as follows: The material to be treated is vaporized by any convenient means and mixed with air. The resulting gas mixture is then heated to the proper temperature and passed over a suitable catalyst. The treated gas mixture is cooled and the product is collected by condensation, scrubbing or other means. The process generally is carried out at atmospheric pressure, and is continuous.

In a reaction such as the oxidation of toluene, it is obvious that several products are possible. In this case the introduction of successive atoms of oxygen would form in turn benzyl alcohol, benzaldehyde, benzoic acid, and finally degradation products formed by rupture of the ring. In practice all of the possible intermediate compounds are formed to some extent, and some of the treated material is completely burned to carbon dioxide and water. In many cases, however, the desired products may be made to predominate by careful regulation of reaction conditions. Important factors which must be controlled are: (a) the temperature at which the reaction occurs, (b) the type of catalyst, (c) the time of contact of the reacting materials

[1]Marek, L. F. and Hahn, D. A., *The Catalytic Oxidation of Organic Compounds in the Vapor Phase* (New York: Chemical Catalog Co., 1932).

with the catalyst, and (d) the ratio of air to reacting material in the initial gas mixture. For example, in the oxidation of toluene over vanadium pentoxide, good yields of benzaldehyde can be obtained at high temperature and short time of contact, while at lower temperature and longer time of contact benzoic acid is the principal product.[2] Thus it is evident that in developing such reactions into commercial processes sufficient experimental work must be carried out to determine the optimum conditions for high yields of the desired product.

One of the most important factors influencing the course of air oxidation is the catalyst employed. A great many substances have been investigated, but only a very few have been found to be effective. The oxides of elements in the fifth and sixth periodic groups, especially those of vanadium and molybdenum, have been found to be the most effective.[3] Some salts of vanadic acid, notably tin and bismuth vanadates, also have been found to possess valuable catalytic properties. In most industrial processes vanadium pentoxide deposited on a suitable support (pumice, asbestos, aluminum, etc.) is used.

In view of the foregoing it seemed possible that catalytic oxidation might be applied to the hydrocarbon constituents of turpentine to form valuable products which would provide additional outlets for the turpentine produced by the South's naval stores industry.[4] Accordingly, a research project was undertaken by the Naval Stores Laboratory of the University of Florida which has as its object the development of technique for the vapor phase catalytic oxidation of terpene hydrocarbons. Much time has been devoted to overcoming technical difficulties inherent in such procedures, and for this reason little data are as yet available. Nevertheless, it seems worth while to report on the work in progress and to indicate what reaction products may be expected. The material being studied at present is alpha-pinene, a terpene hydrocarbon which comprises about seventy percent of American gum turpentine.[5]

[2]Weiss, J. and Downs, C., "Benzaldehyde," *U. S. Pat.* 1,321,959 (1919); Green, S. J., *Industrial Catalysis* (New York: Macmillan Co., 1928), p. 125.

[3]Maxted, E. B. and Coke, B. E., "Catalytic Oxidation of Hydrocarbons," *Brit. Pat.* 228,771 (1925).

[4]Schrauth, W., "Maleic Acid by Catalytic Oxidation of Turpentine Oil," *U. S. Pat.* 2,030,802 (1936). The author indicates such a process, but does not specify reaction conditions or yield of products.

[5]Egloff, G., *Reactions of Pure Hydrocarbons* (New York: Reinhold Publishing Co., 1937), p. 195.

The apparatus which has been developed for this study operates essentially as follows: Air from the laboratory mains passes through a purification train into a reservoir, in which the pressure is held constant by means of a manostat. Two streams of air flow from the reservoir through orifice meters which measure the volume of air fed to the reaction. One stream flows directly to the converter, while the other bubbles through a column of pinene contained in a carburetor maintained at constant temperature in a thermostat. This stream, saturated with pinene, mixes with the stream of pure air as it enters the converter. The converter, which is immersed in a bath maintained at constant temperature, consists of a U-tube the inlet leg of which is filled with aluminum pellets which distribute heat to the incoming gas. The outlet leg contains the catalyst which is vanadium pentoxide deposited on pumice. The treated gas stream passes directly to a pair of water scrubbers immersed in ice, thence to a trap immersed in a freezing mixture, and finally through a charcoal scrubber.

The reaction temperature is set at any desired value by regulating the temperature of the bath surrounding the converter. The ratio of pinene to air in the incoming gas mixture is set at any predetermined value by regulating the relative amounts of air flowing in the two streams and by adjusting the temperature of the carburetor. The time of contact of the reacting gases with the catalyst is set by regulating the total rate of flow of the air entering the apparatus. Accordingly, the optimum experimental conditions may be found from a series of runs in which one variable at a time is changed.

Analysis of the product is carried out as follows: The contents of the scrubbers and traps are washed into a volumetric flask and made up to volume. If oily products are present, these are allowed to collect on the surface and are removed before making up to volume. An aliquot of the aqueous layer is titrated to determine the total acidity. The acid appears to consist almost entirely of maleic acid, and this is determined by precipitating and weighing as the barium salt.[6] The oily products appear to consist chiefly of unoxidized monocyclic terpens with some unchanged pinene.

At present attention is being directed toward finding the optimum conditions for the formation of maleic acid, since this appears to be the principal oxidation product. Yields so far obtained are too low for successful commercial operation, but there is reason to believe that these can be greatly improved once the proper combination of operating variables has been found.

[6]Milas, W. A. and Walsh, W. L., *J. Am. Chem. Soc.*, Vol 57 (1935), p. 1389.

Considerable amounts of formaldehyde have been found in the reaction product, but this substance is not of sufficient value to be considered as anything but a by-product. Its formation is of theoretical interest, however, in that it may throw light on the mechanism of the reaction. Much more detailed data must be obtained before a reaction mechanism can be suggested.

CATALYTIC HYDROGENATION OF OLEO-RESIN FROM THE SLASH PINE (PINUS CARIBAEA)

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Since ancient times man has obtained from the coniferae a resinous balsam from which is derived turpentine and rosin. This resinous balsam as it is collected from the tree is known as oleo-resin.

Oleo-resin consists principally of a mixture of the following: (a) turpentine (about 20%), (b) acids (about 70%), (c) non-saponifiable material (about 10%). The oleo-resin is subjected to steam distillation for the removal of the turpentine, which being volatile, distils off, leaving the acids and the non-saponifiable material.

Turpentine is essentially a mixture of alpha-pinene (I) and beta-pinene (II). The approximate percentages are 65% alpha-pinene, 30% beta-pinene, and 5% residue. The two pinenes are separated by fractional distillation under reduced pressure.

The mixture of acids in the oleo-resin consists mainly of *d*-pimaric (V) and *l*-pimaric (VII), *l*-pimaric being more abundant than the former. The name *l*-pimaric originally given to that acid was a misnomer, since it is seen from the formulas (V) and (VII) that it is not an optical isomer of *d*-pimaric acid. It has been renamed *l*-sapietic acid.[1]

It is necessary in our work to separate these acids. There are several methods by which this may be accomplished, but the method of Palkin and Harris[2] seems to give most favorable results. The essential details are as follows: The oleo-resin containing the settled crystalline acids is filtered and the crystals extracted twice with 80% alcohol. Recrystallization from 95% alcohol gives acids in sufficient concentration to produce a crystalline ammonium salt. These acids are then converted into the sodium salt with half-normal sodium hydroxide at a temperature not over 50° C., and are precipitated with excess of the alkali. These salts are recrystallized once from

[1]Hasselstrom, T. and Bogert, M. T., "Certain Sapinic Acids from Pine and Spruce," *J. Am. Chem. Soc.*, Vol. 57 (1935), p. 2118.

[2]Palkin, S. and Harris, C., "The Preparation of Pimaric Acids from Pinus Palustris," *J. Am. Chem. Soc.*, Vol. 55 (1933), p. 3677.

warm alcohol. The mixture of sodium salts is dissolved in a sufficient quantity of warm alcohol (about 50° C.) so that the concentration is not more than 500 grams per liter. Then the proper amount of 2 *N* acetic acid in an alcoholic solution is added. Fractional crystallization of the regenerated acids gives pure *l*-sapietic acid.

An alternate method for the above step is to carry out a fractional crystallization of the sodium salts.

The non-saponifiable portion consists of neutral bodies about which very little is known. It seems to consist of a mixture of esters, sesquiterpenes, oxidation products and hydrocarbons.

Rosin is not present in the oleo-resin, but is formed as a result of the heating during the distillation. The following actions take place: (a) *d*-pimaric remains unchanged and appears as such in rosin, (b) *l*-sapietic isomerises to another acid which is called abietic acid, VIII.

There is still some discussion as to the position of the double bonds in abietic acid, but absorption spectra suggest that the bonds are conjugated as shown in the accompanying figure.

Abietic acid can be separated readily in pure form by treating an alcoholic solution of *d*-pimaric and abietic acids with a calculated quantity of sodium hydroxide, as abietic forms what is known as the "quarter sodium salt." Its empirical formula is $(C_{20}H_{30}O_2)_3 \cdot C_{20}H_{29}O_2Na$.

The non-saponifiable material is still present in the rosin in about the same proportion as in oleo-resin; however, it is now referred to as "resene" and, as previously mentioned, very little is known about it.

The aim of this investigation is to hydrogenate catalytically the oleo-resin as it comes from the tree. It is hoped that after pressure hydrogenation a more stable product will result which will be of more commercial value in the making of paper sizes, soaps and varnishes.

The present practice in the naval stores industry is to remove turpentine first and then hydrogenate the rosin, but so far results are not particularly favorable. A product is obtained which is not entirely stable toward oxidation.

We know that under certain conditions both *alpha* (I) and *beta* (II) pinene are hydrogenated to pinane (III), while under other conditions they are converted to *p*-menthane (IV).

We are more concerned with the effect of hydrogenation on the acids present in the oleo-resin. It is possible to hydrogenate *l*-sapietic

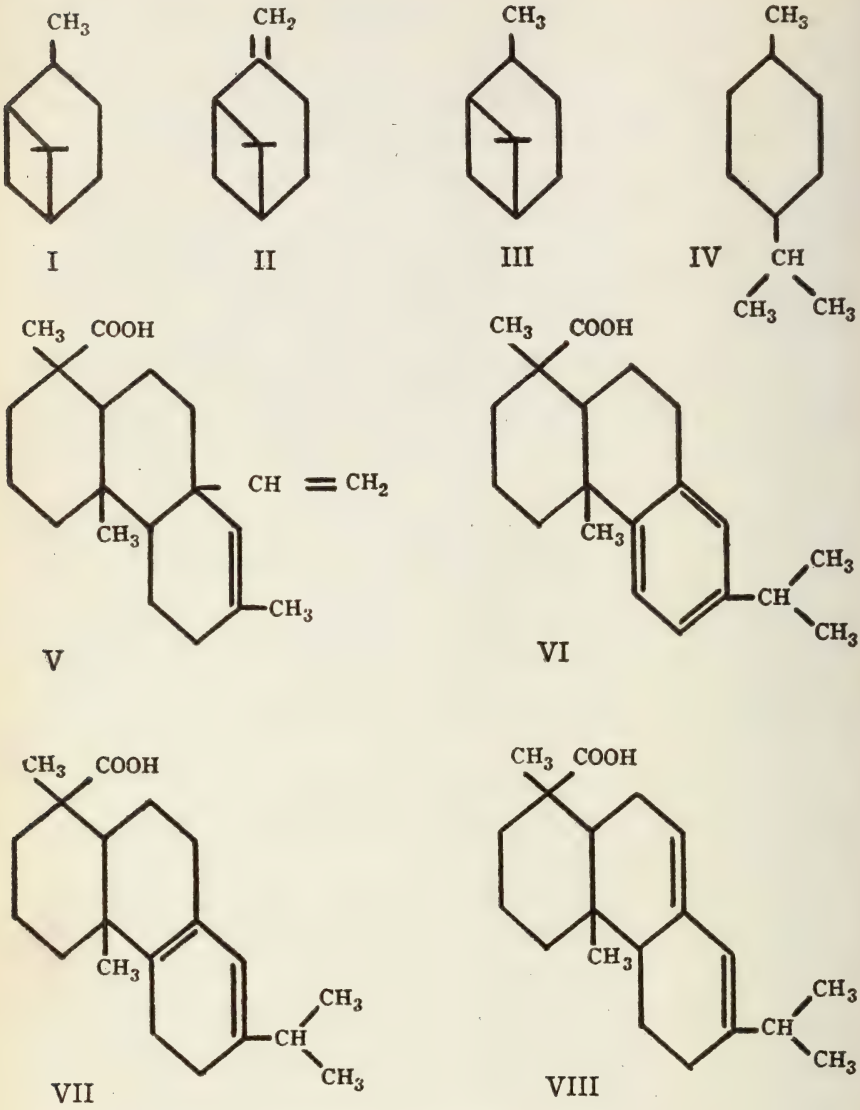

FIG. 1.—Structural Formulas for Some Terpenes and Acids.[3]

[3]Other structures have been suggsted for the acids represented by VII and VIII. See Fieser, L. F. and Campbell, W. P., *J. Am. Chem. Soc.*, Vol. 60 (1938), p. 159, and Fleck, E. E. and Palkin, S., *J. Am. Chem. Soc.*, Vol. 61 (1939), p. 3197.

acid to the di-, the tetra-, and the hexahydro-*l*-sapietic acids. As can be seen from formula VII, three isomers of dihydro-*l*-sapietic acid can be formed, depending upon which double bond is hydrogenated. Two isomers of the tetrahydro acid can be formed, depending upon which two double bonds are hydrogenated.

D-pimaric acid, V, can also be hydrogenated catalytically to the di- and tetrahydropimaric acids. The tetra acid is more difficult to obtain.

When abietic acid is dehydrogenated, dehydroabietic acid, VI, results.

Success in hydrogenating at least some of the acids in the oleo-resin has been attained. The amount of hydrogen absorbed is in excess of that consumed in converting the pinenes to pinane or *p*-menthane. The quantity of dihydroabietic acid produced is about four times as much as has been reported present in the oleo-resin.[4]

[4]Palkin, S. and Fleck, E. E., "The Presence of Dihydroabietic Acid in Pine Oleo-resin and Rosin," *J. Am. Chem. Soc.*, Vol. 61 (1939), pp. 1230-1232.

DEHYDROABIETIC ACID AND CERTAIN OF ITS DERIVATIVES

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Dehydroabietic acid, VI, is one of the acids formed by the disproportionation of abietic acid, VIII, when abietic acid is treated with a palladium and charcoal catalyst and heated to 250°C. The formula of abietic acid as given in the paper of Stearns and Hawkins[1] is well established as to all groups and positions; the only question that arises is one as to the location of the double bonds. It is established that they are conjugated; the question, therefore, is whether they are both in ring two, or are divided between rings two and three. In regard to the disproportionation mechanism, the relative position of these bonds is apparently of little importance.

When abietic acid is submitted to a heat treatment for about 300 hours at 250° to 275°C., it becomes stabilized; that is, it is not subject to decolorization by continued standing or exposure to the air as is abietic acid. This stabilized acid is called alpha-pyroabietic acid. Fleck and Palkin[2] have recently shown that the Pd/C catalyst gives the same pyroabietic acid in about forty minutes. If the temperature is carefully controlled and is not allowed to exceed 225°C., the disproportionation is complete and takes place without any appreciable loss of hydrogen. If, however, the temperature is allowed to rise to about 250°C. the amount of dehydroabietic acid is increased at the expense of the formation of the other acids. This increase can be continued until a temperature of 275°C. is reached, with more hydrogen being evolved, as the catalyst at this temperature is more rapidly assuming the role of a dehydrogenation promoter. If the temperature is now allowed to go higher, decarboxylation and demethylation will result and the final product will consist largely of neutral oils. The pyroabietic acid formed by the catalytic method is obtained, in almost theoretical yield, as fine white crystals with definite m.p. of 170°C. and with a rotation of +60°. The isomeric disproportionation reaction may be expressed empirically and qualitatively as follows: $C_{20}H_{30}O_2 \rightarrow C_{20}H_{32}O_2 + C_{02}H_{28}O_2 + C_{20}H_{34}O_2$.

[1]These *Proceedings*, Vol. 4 (1939), pp. 120-123.

[2]Fleck, E. E. and Palkin, S., "Catalytic Isomerization of Rosin," *J. Am. Chem. Soc.*, Vol. 59 (1937), p. 1593.

Dehydroabietic acid is obtained from this mixture of acids by a sulfonation process which was first investigated by Hasselstrom[3] and developed in more detail by Feiser and Campbell[4]. In this process, the entire mixture is treated with concentrated sulfuric acid at -10° to -5°C. Under these conditions only the dehydroabietic acid is sulfonated. The point of attack is the aromatic nucleus and is probably centered on carbon atom number six. The sulfonic acid is then separated from the other acids by various methods, the one being used by the authors is that of ether extraction, making use of the fact that sulfonic acids are insoluble in ether. Upon crystallization from glacial acetic acid, washing with ether and drying, we have obtained a sulfonic acid which melts at 240° to 243°C. and by indirect analysis contains one molecule of water of hydration. This acid may then be converted into dehydroabietic acid by acid hydrolysis at about 135°C. for 15 to 24 hours. The yield in this step is about 60% of the theoretical, not taking into consideration the unused sulfonic acid.

At present derivatives of dehydrosulfoabietic acid which could possess physiological properties are being studied. As it is necessary that these derivatives be from the acid groups, and as this acid is a dibasic acid, the problem is being attacked from the standpoint of both the free acids and the methyl ester of dehydroabietic acid. This permits complete characterization of the resulting compound, and in most cases a satisfactory characterization without ultimate analysis.

Various ammonolysis experiments, too, have been attempted with the view of readily preparing a monoamino derivative in a high yield. No success in this direction has been acomplished as yet. These experiments are being carried out both on the ester and on the free acid. Some mild nitration experiments on the free acid have been made with the view of obtaining a mononitro derivative. So far only a dinitro derivative has resulted. Littmann[5] has shown that it is possible to reduce the dinitro derivative to the diamino derivative by the use of copper-chromium oxide catalyst without affecting the aromatic nucleus.

Since amines are frequently utilized in dyestuffs, it is desirable from a chemical standpoint to prepare the monoamine in order to prevent

[3]Hasselstrom, T. and McPherson, J., "Reactions Involved in the Sulfonation of Heat Treated Abietic Acid," *J. Am. Chem. Soc.*, Vol. 60 (1938), p. 2240.

[4]Feiser, L. F. and Campbell, W. P., "Substitution Reactions of Debydroabietic Acid," *J. Am. Chem. Soc.*, Vol. 60 (1938), p. 2631.

[5]Littman, E., "Action of a Palladium on Abietic Acid," *J. Am. Chem. Soc.*, Vol. 60 (1938), p. 1419.

complications which may arise upon characterization if a diamine is used.

It is planned to submit both the free acid and the methyl ester to a series of Friedel-Crafts reactions for the preparation of various oxygenated derivatives. These should be of interest because of the effect of various side chains on the nucleus. It is also possible that certain of these may give rise to materials which are structurally similar to the sex hormones.

Furthermore, attempts will be made to prepare the aldehyde corresponding to dehydroabietic acid, as this compound, if stable, may undergo many interesting condensation reactions.

As a final part of the problem catalytic hydrogenation of certain of these derivatives to the corresponding dihydro, and tetrahydroabietic acid derivatives will be attempted. This would probably be a most satisfactory method for the preparation of certain non-reducible derivatives of dihydroabietic acid, since this acid is not as easily attacked as is dehydroabietic acid.

Considerable progress along the lines indicated above has already been made.

FflorIda pocket-gopher burrows and their arthropod inhabitants[1]

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More than forty years ago an extraordinary assemblage of beetles, flies and other arthropods was discovered in the burrows of the gopher tortoise by H. G. Hubbard—one of the naturalists who did pioneer work in Florida.[2,3] Some years later, in southern California, Hubbard investigated the fauna of the burrows of jumping mice and spermophiles,[4] and found it almost equally noteworthy. Despite this promising beginning, the arthropod fauna of vertebrate burrows has received but little attention in this country since Hubbard's time. The scattered records of arthropods inhabiting the burrows of larger animals are to be found mostly in the papers of mammalogists,[5] herpetologists[6] and others who were interested primarily in the makers of the burrows,

[1]Contribution from the Department of Biology and the Agricultural Experiment Station of the University of Florida, Gainesville, Florida.

Note: A preliminary account of the discovery of a hitherto unknown arthropod fauna in the burrows of Florida pocket-gophers *(Geomys)* was given by Mr. Goff at the 1938 meeting of the Florida Entomological Society. His sudden death early the following year [*Florida Entomologist,* Vol. 22 (1939), No. 1] prevented him from continuing his investigations or preparing his results for publication. Those who knew of his work were aware of its value and felt that it should be published. Having shared in a part of the field work and in identification of the specimens secured, I undertook to write this paper, which is based very largely upon Goff's notes and materials.—T. H. Hubbell.

[2]Hubbard, H. G., "The insect guests of the Florida land tortoise." *Insect Life,* Vol. 6 (1894), pp. 302-15.

[3]Hubbard, H. G., "Additional notes on the insect guests of the Florida land tortoise," *Proc. Ent. Soc. Washington,* Vol. 3 (1896), pp. 299-302.

[4]Hubbard, H. G., "Letters from the Southwest: Insect fauna in the burrows of desert rodents," *Proc. Ent. Soc. Washington,* Vol. 4 (1901), pp. 361-64.

[5]Criddle, S., "The prairie pocket-gopher, *Thomomys talpoides rufescens," Journ. Mammalogy,* Vol. 2 (1930), pp. 265-89, pl. 15, 3 figs.—Hatt, R. T. "Notes on the ground-squirrel, *Callospermophilus," Occ. Papers Mus. Zool. Univ. Michigan,* No. 185 (1927), 22 pp., 1 pl., 2 figs.

[6]Hallinan, T., "Observations made in Duval county, northern Florida, on the gopher tortoise, *(Gopherus polyphemus)," Copeia,* No. 114 (1923).

and in studies devoted to particular groups of insects.[7] We may contrast the paucity of our knowledge concerning the inquilines of vertebrate burrows in America with the situation in Europe, where a number of workers have revealed the existence of interesting assemblages of pholobiont arthropods in the holes of rodents[8] and moles[9], and where various methods of studying burrow-faunas have been devised.[10] One may judge what an extensive and almost untouched field of exploration here lies open to American students, by the recent summary of our knowledge of the fauna of gopher tortoise burrows by Young

[7]Blatchley, W. S., "The Scarabaeidae of Florida," *Florida Ent.*, Vol. 11 (1927), pp. 44-46, (1928) pp. 55-62; Vol. 12 (1928), pp. 9-14, 22-30, 44-46, 63-65.—Hubbell, T. H. "A monographic revision of the genus *Ceuthophilus* (Orthoptera, Gryllacrididae, Rhaphidophorinae)," *Univ. Florida Publ., Biol. Sci. Ser.*, Vol. 2, No. 1, (1936), 551 pp., 3 figs., frontispiece and 38 pls.—Johnson, C. W. "Insects of Florida. I. Diptera," *Bull. Amer. Mus. Nat. Hist.*, Vol. 32, No. 3 (1913), pp. 37-90.

[8]Bouvier, E. L., "Sur les arthropodes commensaux de la marmotte des Alpes," *Comptes Rendus Acad. Sci. France,* Vol. 188 (1929), pp. 575-77.

Marié, P., "Recherche des insectes commensaux des marmottes," *Bull. Soc. Ent. France,* (1926), pp. 13-16.

———, "Recherche des insects microcavernicoles propres aux terriers de marmottes," *Bull. Soc. Ent. France,* (1927), pp. 64-73, 1 pl.

———, "Nouvelles captures d'insectes biblogiquement adaptés aux terriers de marmottes," *Bull. Soc. Ent. France,* (1927), pp. 256-60.

———, "Contribution à l'étude et à la recherche des arthropodes commensaux de la marmotte des Alpes," *Ann. Sci Nat.*, Paris, Ser. 10, Vol. 13 (1930), pp. 185-233.

Medvedev, S. L., "De nova Gryllidarum specie im latibulis Citellorum in tesquis Ponticis vivente (Orthoptera)," [*Gryllomorpha miramae* n. sp. in *Citellus* burrows in Crimea] *Rev. Ent. U. S. S. R.*, Leningrad, Vol. 25 (1933), pp. 179-81, 4 figs.

[9]Heselhaus, F., "Über Arthropoden in Nestern," *Tijdschr. v. Ent.*, 's Gravenhage, Vol. 57 (1914), p. 62.

———, "Weitere Beiträge zur Kenntnis der Nidicolen," *op. cit.*, Vol. 58 (1915), pp. 251-74.

——— and Schmitz, H., Über Arthropoden in Maulwursnestern," *op. cit.*, Vol. 56 (1913), pp. 195-237.

Jarrige, J., "Le nid du taupe, mileu biologique, et ses commensaux en S.-et-O," *Bull. Soc. Sci. Nat.*, Seine-et-Oise, Versailles, Ser. 3, Vol. 1 (1933), pp. 64-67.

[10]Falcoz, L., *Contribution a l'étude de la faune des microcaverns. Faune des terriers et des nids* (Lyon: A. Rey, 1914), 187 pp.

Korotnev, N., "Faune des nids et terriers et les moyens de leur recherche," *Bull. Soc. Ent. Moscow,* Vol. 2 (1922), pp. 75-94.

and Goff,[11] and by the results, here presented, of little more than one season's work on the arthropod fauna of *Geomys* burrows in Florida.

One might perhaps wonder why the inquilines of mammal burrows have not been more studied were the reason not so obvious. It was expressed very well indeed in the closing remarks of Hubbard's "Letters from the Southwest":—"Benito and I dug four days at these burrows and I paid him $1.25 per day, so that the few insects found are valuable. I feel sure that there are more things to be found in subterranean mammal's holes, but the labor and expense of unearthing them are very great. It quite tired me out."

In studying the life history, habits and control of Florida pocket-gophers of the genus *Geomys,* Goff examined numerous burrows to determine their depth, plan and extent. Many arthropods were encountered during the course of this work. When one of these was found by Hubbell to constitute a remarkable undescribed genus and species of "cave-cricket" or cricket-locust allied to *Ceuthophilus,*[12] but blind and evidently highly adapted to commensal life with pocket gophers, an intensive study of the entire arthropod fauna of the burrows was begun. Two large burrow systems near Leesburg, Florida were completely excavated, and so far as possible all animals found in them were collected. Later it was determined that trapping the arthropods was less laborious and more effective, and trap-jars were placed in many burrows in various parts of the state. Some of the insects were collected alive, and established in glass-topped artificial "burrows" for observation of their habits and for life history studies; others found in immature stages were reared to maturity in cages. The results of this work, while still far from complete, are of such interest that we hope they will induce other persons to make similar investigations on the burrow faunas associated with *Geomys, Thomomys* and *Cratogeomys* throughout the ranges of these pocket-gophers. It will also be of interest to compare the faunas of the normally closed burrows of pocket-gophers with those of open burrows such as are made by most burrowing reptiles, mammals and birds.

This paper treats the occurrence and characteristics of *Geomys* burrows in Florida, the methods found most useful for locating them and

[11]Young, F. N. and Goff, C. C., "An annotated list of the arthropods found in the burrows of the Florida gopher tortoise, *Gopherus polyphemus* (Daudin)," *Florida Ent.,* Vol. 22 (1939), No. 4, pp. 53-62.

[12]Hubbell, T. H., "A blind cricket-locust *(Typhloceuthophilus floridanus* n. gen. et sp.) inhabiting *Geomys* burrows in peninsular Florida. (Orthoptera, Gryllacrididae, Rhaphidophorinae)," *Ann. Ent. Soc. Amer.,* Vol. 33 (1940), pp. 10-32, pl. 1, figs. 1-5.

for collecting their arthropod inhabitants, the species encountered and what is known of their rôles in the burrow biocoenose.

We wish to express our appreciation of the help received from various sources during the course of our work. For assistance in determining the arthropods collected we are especially indebted to Dr. O. L. Cartwright of the Clemson Agricultural College, Clemson, S. C. Others who have aided in identification are: Dr. J. Bequaert of the School of Tropical Medicine, Harvard University, Cambridge, Mass.; Dr. R. V. Chamberlin of the University of Utah, Salt Lake City, Utah; the late Mr. H. C. Fall of Tyngsboro, Mass.; Mr. Irving Fox of the Iowa State College, Ames, Iowa; Mr. C. A. Frost of Framingham, Mass.; Messrs. Wm. L. Jellison and R. A. Cooley of the Rocky Mountain Laboratory, U. S. Public Health Service, Hamilton, Mont.; Mr. J. T. Lucker of the Bureau of Animal Industry, Washington, D. C.; Mr. E. D. Quirsfeld of Hillsdale, N. J.; Dr. H. B. Mills of the Montana State College, Bozeman, Mont.; Dr. E. S. Ross of the California Academy of Sciences, San Francisco, Cal.; and the following members of the staff of the Bureau of Entomology and Plant Quarantine, Washington D. C.: Messrs. H. S. Barber, L. L. Buchanon, August Busck, E. A. Chapin, R. A. Cushman, H. E. Ewing, C. T. Greene, A. B. Gurney, D. G. Hall, H. R. Johnson, C. F. W. Muesebeck, M. R. Smith, Alan Stone, and Miss Grace A. Sandhouse. We are also indebted to several of our colleagues and students in the University of Florida: to Dr. H. K. Wallace for identifying arachnids found in the burrows, and for permission to use his records of material trapped near Gainesville, Florida; to Messrs. B. A. Barrington and J. J. Friauf for data and specimens which they kindly permitted us to record in this paper; to Mr. F. N. Young for identification of Coleoptera and other coöperation;[13] and to Dr. H. B. Sherman for information concerning the habits, distribution and classification of Florida pocket-gophers, and for helpful criticism.

GEOGRAPHIC AND ECOLOGIC DISTRIBUTION OF POCKET-GOPHERS IN FLORIDA

Pocket-gophers of the genus *Geomys* (locally known as "salamanders") are abundant in many parts of Florida, but they do not occur everywhere in the state. They occupy many large and small areas of sandy soil scattered throughout most of north Florida and the northern part of the peninsula, and are generally absent from the intervening areas of marsh and swamp, flatwoods and hammock.

[13]Goff's data on the arthropods found in burrows of the Florida gopher tortoise (*Gopherus polyphemus*) were turned over to Mr. Young, who incorporated them with his own notes and prepared the paper by Young and Goff cited in footnote.[11]

South of a line drawn from Tampa through Winter Haven to Melbourne, they occur principally in the ridge section of Polk County and the northwest part of Highlands County, and thence south and southwest to Charlotte County as isolated colonies. This discontinuous distribution in the state is the result of the "patchy" occurrence of areas having deep, well-drained sandy soils, to which pocket-gophers are almost restricted in this region. *Geomys* is especially abundant in and characteristic of the soil type known as Norfolk fine sand—the Norfolk sands being the most extensive and widely distributed of the Red and Yellow soils occurring in Florida. Less often pocket-gophers may be found in sands of the Eustis, Blanton, Orlando and Ft. Meade series, and even occasionally in the deep dune-sand soils of the St. Lucie and Lakewood series.[14]

High-Pine—Turkey Oak

In Florida the Norfolk sands are largely coextensive with the wide-spread and easily recognizable major habitat known as "high-pine—turkey oak." This habitat covers large tracts in the interior of the peninsula and in northern Florida, and possesses a distinctive biota. In its original condition it was dominated in most places by long-leaf pine *(Pinus australis)*, or by an intermixture of long-leaf and slash pine *(P. palustris)*, with a sparse understory of scrubby oaks. With removal of the great pine forests by lumbering, large tracts have reverted to an earlier successional stage[15] known as "turkey oak."

[14]For the characteristics and distribution of these soils see Henderson, J. R. "The Soils of Florida," *Univ. Florida Agr. Exp. Sta. Bull.*, No. 334 (1939), 67 pp., 5 figs., 2 maps in folder. The "Norfolk sands" of the older soil surveys included soils now placed in the Eustis, Blanton, Orlando and Ft. Meade series, as well as others. Inspection of Henderson's generalized soil map of Florida will give a fair idea of the distribution of *Geomys* in the state, since most of the known occurrences fall within the areas shown as Blanton-Norfolk and as Norfolk-Orangeburg.

[15]This is supposition, since so far as we are aware the successional stages in this sere have not yet actually been determined. The frequent presence of long-leaf pine seedlings in stands of "turkey oak" seems to indicate that reversion to "high-pine" will occur in the absence of disturbance. On the other hand, succession is apparently very slow on the dry sand ridges, and here "turkey oak" may persist for very long periods; the "sand hills" in Bartram's time (1773-8) were covered with a "turkey oak" forest as they are today. There is reason to regard "high-pine" as a persistent sub-climax maintained and prevented from reaching climax "hammock" by frequently recurrent ground-fires; or, to be less theoretical, as the actual climax over large areas of the southeastern coastal plain in which fire has always been a normal and regularly recurrent environmental factor.

This is a scrubby oak forest composed largely of the same two species which appear in the understory of "high-pine"—*Quercus laevis* (turkey oak, often called "black-jack" in Florida), and *Q. cinerea* (upland willow oak, often called "blue-jack," sometimes "turkey oak"), in pure or mixed stands. Although "turkey oak" forest is very different in appearance from "high-pine," the vegetation and fauna of the lower strata of the two habitats are so similar that for most ecological purposes they may be regarded simply as variants of a single major animal habitat, "high-pine—turkey oak."

The turkey oak forest is typically more or less open, with occasional large pines and scattered pine seedlings often present. Where the trees are rather closely spaced the ground beneath is often bare, or covered only by sparse herbage and windrows of dead oak leaves. The soil is sandy and well-drained, with a grayish surface over a yellowish substratum. In the more open, sunny parts of the forest the ground vegetation is more dense, consisting of a rather thin growth of wire grasses (chiefly *Aristida stricta)* and numerous species of herbs, including goat-rue *(Cracca* sp.), pencil-flower (*Stylosanthes* sp.), rattlebox (*Crotalaria rotundifolia*), partridge pea (*Chamaecrista bracheata*), Summer-farewell (*Kuhnistera pinnata*), green-eyes (*Berlandiera subacaulis*), dog-tongue (*Eriogonum tomentosum*), prostrate milkweed (*Asclepias humistrata*), *Pediomelum canescens, Carphephorus corymbosus* and others. An occasional clump of dwarf pawpaw *(Pityothamnus angustifolia),* low thickets of oak seedlings, and spreading patches of gopher apple *(Geobalanus oblongifolius)* and sometimes of dwarf chinquapin (*Castanea alnifolia*) are also characteristic. The large, open-mouthed burrows of the gopher tortoise *(Gopherus polyphemus)* and the bare sandy mounds of "salamanders" *(Geomys)* are usually numerous and conspicuous.

Sand Scrub

The second type of major habitat in which pocket-gophers occur to some extent in Florida is the "sand scrub." This habitat, characteristic of the St. Lucie and Lakewood dune-sand soils, is one of the most peculiar and distinctive of the major terrestrial habitats found in the state. It extends in a narrow and occasionally interrupted belt along the east coast of the peninsula, forms a similar but less extensive coastal strip along the gulf coast in west Florida, and exists in the interior of the peninsula as several large areas (the greatest of which is the "big scrub" of the Ocala National Forest) and a multitude of small island-like patches surrounded by other types of environment—turkey oak, flatwoods, hammock, swamp and marsh. The soil of the scrub is deep, well-drained sand, grayish white at

the surface and its deeper portions either white (St. Lucie), or yellow (Lakewood).

In a broad sense, the term "sand scrub" includes a series of successional stages following bare dune and grassy dune. As a whole it is by far the most xeric of any of the major terrestrial habitats of Florida. The earlier phases are characterized by the presence of a low, scrubby, interlocking growth of dwarf oaks and other shrubs, forming dense thickets more or less interrupted by room-like spaces floored with bare whitish sand. Away from the coast these early successional stages are dominated by myrtle oak (*Quercus myrtifolia*), twin live-oak (*Q. geminata*), and Chapman's oak (*Q. chapmanii*), mingled with staggerbush (*Xolisma ferruginea*), silk bay (*Tamala humilis*), wild olive (*Amarolia sp.*) and saw palmetto (*Serenoa repens*). A dwarf palm (*Sabal etonia*) is abundant in the extensive Ocala scrub. Rosemary bushes (*Ceratiola ericoides*) often form dense and nearly pure stands, especially in disturbed areas, and occur as scattered clumps until the forest stage is reached. In low areas, and especially where the scrub borders ponds and flatwoods, fetterbushes (*Desmothamnus lucidus*) and wax myrtle (*Cerothamnus cerifera*) often grow profusely among other shrubs more characteristic of the scrub. In the dune belts along the coasts saw palmetto is often dominant, and here there are also many invading maritime plants.

As succession continues young sand pines (*Pinus clausa*) become established. The scrub thickets grow taller and denser, but eventually they are overshadowed and largely replaced by a sub-climax forest dominated by the sand pines. This forest is typically rather open and sunny, with a scattered understory composed of the scrub oaks and other shrubs surviving from the earlier stages; a low shrub and herbage stratum develops, in which blue berries (*Cyanococcus myrsinites*) and bracken fern (*Pteris latiuscula*) are prominent; and the ground is carpeted with pine straw and reindeer moss (*Cladonia* sp.).

The "sand scrub" habitat is noteworthy for the number of species of plants and animals which are confined to it, and for the extent to which isolation of the principal scrub areas has fostered speciation in certain groups of animals such as flightless grasshoppers. Neither the pocket-gopher nor the gopher tortoise can be regarded as a characteristic scrub-inhabitant; the former occurs only in the pre-forest stages of the scrub succession, and both are entirely absent from many scrub patches.

Geographic Isolation in Relation to Geomys and the Burrow Inquilines

The close correlation between the occurrence of particular soil types and the presence of *Geomys* has been amply demonstrated by the

detailed field studies made by Dr. H. B. Sherman, with whose observations our own more limited experience is in accord. This relationship not only makes it possible to use detailed soil maps of Florida for locating pocket-gopher colonies in previously unvisited territory, but also enables one to form a fairly accurate general concept of the present distribution of these animals in the state.

Where there are large and relatively continuous areas of Norfolk and similar sands, as in the interior of the northern part of the peninsula and southward in the ridge section, *Geomys* occurs almost everywhere that these soils do. On the outskirts of these areas, however, the distribution of suitable soils becomes highly discontinuous. Thus, to the east of the St. Johns River there are large and small "islands" of turkey oak and sand scrub, isolated from those to the west by the river, and from those bordering the east coast by a broad intervening zone of flatwoods and swamp. Some of the isolated patches bordering the east bank of the St. Johns River and some of those on the coast harbor colonies of *Geomys,* others do not. In this region colonies have been found at San Mateo, between Satsuma and DeLand, and on the coast at St. Augustine and Eau Gallie. Similarly, to the south and southwest of the ridge section, an "archipelago" of turkey oak and sand scrub "islands" extends to the vicinity of Palmdale and Punta Gorda; pocket-gophers are present on some of these as far southwest as the latter locality. Along the west coast of the peninsula, also, more or less completely isolated colonies exist in places, as near Sumner in Levy County.

The isolation between the major scrub areas has been sufficiently complete and of long enough duration to permit the differentiation in them of related but perfectly distinct species of brachypterous grasshoppers. It is probable that the areas of Norfolk sands have had an almost equally long independent history, the coastal areas being the youngest. It would not be surprising, therefore, to find that specific or racial differentiation corresponding to the degree of isolation had occurred, both in *Geomys* itself, and in at least some of the arthropods inhabiting the burrows. To some extent this appears to have taken place in *Geomys*. We are informed by Dr. H. B. Sherman (who is revising the pocket-gophers of the southeastern states) that although the problem is still under investigation, there is reason to believe that some of the isolated populations of *Geomys* are racially or perhaps even specifically distinct from the bulk of the peninsular population. On the other hand, there is no evidence that corresponding differentiation has occurred in any of the inquiline species (with the doubtful exception of the "blind cricket" previously mentioned). The arthropod

fauna of burrows in widely separated localities was found to be practically identical, save as particular species were present or absent from the collections.

Fourteen of the inquiline arthropods found in our work appear to be true obligate pholobionts, more or less highly adapted to life in the burrows and evidently long associated with *Geomys*. In this group of species are two centipedes, one spider, one Thysanuran, one blind cricket-locust, one mallophagan parasite of the pocket-gopher, four histerid beetles, two scarabaeid beetles, one tineid moth, and one anthomyiid fly. All of these except the spider, the mallophagan and perhaps the fly are new species, among which are represented three new genera. To this list should probably be added the flea *Foxella ignotus*, which we did not find; and additional obligates doubtless remain to be discovered.

If these obligate inquilines normally spread from burrow to burrow underground, and rarely reach the surface—a hypothesis developed below—then it follows that their presence in the burrows of different races or species of pocket-gophers is the result of an association with *Geomys* that antedates the differentiation that has occurred in that animal, and hence that evolutionary modification is proceeding at a slower rate in the burrow-inhabiting arthropods than in their host.[16] It would probably be safe to assume that the burrow fauna has evolved concomitantly with, though more slowly than *Geomys*, and that when the ancestors of these mammals first began to close their burrows off from the surface, the burrows were already occupied by the progenitors of some of the more completely adapted arthropods found in them today. Certain elements of this association probably date back at least to early Pleistocene and not improbably to late Pliocene.

[16]Throughout the Cenozoic mammals and birds have changed far more rapidly than insects, and this fact has been utilized in determining phylogenetic relationships among warm-blooded vertebrates by the affinities of their parasites, particularly Mallophaga and fleas. Furthermore, the pholobiont fauna may be expected to exhibit in somewhat lesser degree the archaic characteristics so frequently commented upon in the case of cavernicolous arthropods. The relatively low and constant temperature in caves and burrows suggests the operation of Kennedy's principle [*Ecology*, Vol. 9 (1928), pp. 367-79] that rate of evolutionary change in insects is inversely proportional to environmental temperature (species of high latitudes, those becoming adult in spring and fall, and those which are nocturnal or crepuscular during their periods of activity being in general more primitive than related types occurring in the tropics, occurring adult in summer, or which are diurnally active). The monotonous, unchanging environment of caves and burrows is also probably not conducive to rapid evolutionary modification once a fair degree of adaptation has been attained.

CHARACTERISTICS OF *GEOMYS* BURROWS IN PENINSULAR FLORIDA

Detailed studies of several *Geomys* burrows were made by Goff in a colony of these animals that inhabits a high-pine grove on soil identified as Orlando fine sand, just north of the Leesburg branch of the Florida Experiment Station, in Lake County, Florida. Two of the burrows were completely excavated and mapped, and partial excavation of numerous others in this vicinity and elsewhere in the state indicates that the ones studied in detail were quite typical. Crouch[17] has given an excellent generalized account of pocket-gophers and their burrows, but since his descriptions cover the burrowing habits of three genera (*Geomys, Thomomys* and *Cratogeomys*) in different regions and under various soil and climatic conditions, we present here a description of the burrows of *Geomys* as we have observed them in the sandy soils of Florida.

Description of a Single Burrow

The more extensive of the two burrows which were studied in detail is illustrated by the diagram shown in Fig. 1. This burrow was constructed by an adult female *Geomys,* which was trapped on April 13th. On the same date a molasses trap was placed in the burrow; on the 15th the trap was found to contain 17 "blind crickets" and a number of beetles and flies. Excavation and mapping of the burrow were begun on the 15th and completed the 27th, requiring a total of 21 man-hours of digging. In the course of this work 75 additional "blind crickets" and a number of beetles, flies and moths were encountered in the portion of the burrow to the left of the earth plug shown at P; a smaller number of these were found in the right-hand portion of the burrow.

The burrow varied from 5 to 7 centimeters (2 to 2.8 inches) in diameter throughout most of its extent. The depth of the tunnel beneath the surface, measured to the center of the opening, varied from 10 to 100 centimeters (4 inches to 3 feet 4 inches), with the greater part lying at a depth between 20 and 40 centimeters (8 to 16 inches). At point P the burrow was loosely plugged with earth; the portion to the left of this plug, including branches, was approximately 125 meters (406 feet) in length, that to the right of P about 42 meters (136+ feet), giving a total length of open burrow of about 167 meters

[17]Crouch W. E., "Pocket-gopher Control," *U. S. Dept. Agr., Farmers Bull.,* No. 1709 (1933), 20 pp., 17 figs.

FIG. 1.—Diagram of *Geomys* burrow excavated near Leesburg, Florida, shown in plan, and drawn to scale except for the width of the burrow. The diagram is ruled into 5 meter squares. Dotted circles show the location of surface mounds; solidly black portions of the tunnel were plugged with earth. D was the deepest point of the burrow, 100 centimeters; the short projection at F was a fecal chamber; P was a loosely plugged portion of the burrow; S was a sharp spiral turn. X, Y, Z are reference points mentioned in the text. The cross-lined circles represent the bases of trees.

(542+ feet).[18] The maximum depth of 100 centimeters occurred at point D; at F there was a side chamber in which about a quart of pocket-gopher feces had been deposited; at S the burrow formed a sharp spiral, entering from the left at a depth of 80 centimeters and leaving to the right at a depth of 40 centimeters.

At no point on this burrow was there found an unplugged opening to the surface of the ground. Sixty-seven earth mounds had been thrown up along the course of the burrow; 42 of these were situated along 52 meters of terminal branches (distad of points X, Y, Z), while there were only 25 mounds along the remaining 115 meters of open burrow. The amount of sand in these mounds was estimated insufficient to account for more than one-half or two-thirds of that displaced in digging the burrow. A part of the discrepancy may be accounted for on the hypothesis that the soil around the burrow is compacted; in this particular instance, however, there was evidence that part of the sand had been disposed of beneath the surface, and that the burrow was sufficiently old so that an earlier set of surface mounds had nearly disappeared. Another burrow (or an older part of the same system) was encountered at two points, which had been completely filled with sand for some distance. Such use of abandoned or seldom-used tunnels, either by their makers or by other pocket-gophers that break into them while burrowing, doubtless accounts for the large number of plugged burrows that are generally encountered while digging anywhere in a site where *Geomys* mounds are numerous.

Age of Burrows

It is difficult to estimate the age of a given burrow, and it is not known whether an individual pocket-gopher usually stays in one burrow-

[18]According to Crouch (*op. cit.*, p. 4) single burrow systems with a length of open passageways totalling more than 800 feet are common. He states that the burrows usually lie between 4 and 8 inches beneath the surface, but that in some localities and at certain seasons pocket-gophers may go to a depth of 6 feet; that in the southern parts of the country the burrows lie much closer to the surface in the cooler months than during the summer; and that in digging the deeper tunnels the rodents may place the excavated dirt in the tunnels of a higher level. None of the burrows examined by Goff had interconnected passages at different levels, such as are shown by Crouch (p. 8, fig. 9B); the lowest parts of the burrows were simply unusually deep sections of the main passages. In the Norfolk sands and similar soils of Florida the average depth of the burrows appears to range between 6 and 18 inches; but attempts to excavate several burrows in sand scrub on St. Lucie soil near Leesburg and near Hesperides in Polk County had to be abandoned when the tunnels were found to continue down past depths of 5 to 8 feet.

system throughout its life, or tends to make frequent changes of location. These rodents are sometimes seen wandering at night, and abandoned burrows are not infrequently found. In the case of the burrow here described, faint traces of old mounds, nearly obliterated and concealed by grass, were noticed along the section of the main burrow between X and Z. Judging by the persistence of other mounds of known age and the slow rate at which they flattened out and were overgrown, these nearly effaced mounds must certainly have been made more than one year before the burrow was studied, and more probably several years earlier. Their arrangement showed that they had been made from this burrow, but whether by the current occupant or by an earlier tenant is uncertain. Abandoned burrows may be found and brought into use after a considerable interval by another pocket-gopher than the one which dug them, as shown by the following observation. A pocket-gopher was trapped from a burrow near the edge of the colony mentioned above, and the hole where the trap had been set was left open. Eleven months later this hole was plugged by a pocket-gopher, and a single mound of sand was thrown up near the end of the burrow. Apparently another individual had at last broken into the empty burrow, and instead of using it for disposal of sand had incorporated it into its own system; the burrow was evidently in sufficiently good repair so that only enough sand to form one mound had to be removed to clean it out.

Nest Chamber, Food, and Food Stores

The burrow just described and figured contained no nest chamber nor food stores. In the second of the two burrows fully excavated, a nest chamber was found 40 centimeters (16 inches) beneath the surface, the dimensions of which were 12.5 by 15 centimeters)5 by 6 inches). The nest in this chamber was composed of grasses, still in rather fresh condition; it was swarming with mites, and in it were found several small lepidopterous larvae apparently the same as those later reared from pocket-gopher feces (*Amydria* sp.). A number of flies *(Pegomya* sp.) were also seen in its vicinity. No feces were found either in the nest chamber or elsewhere in this burrow.

The food of pocket-gophers, according to Crouch (*op. cit.*, p. 8) consists chiefly of roots, tubers, bulbs and stems of plants; so far as known these rodents are normally herbivorous. Most of the food is obtained underground, a part being found while making the tunnels, but a greater part being obtained by digging up beneath plants and biting off the roots just beneath the surface of the ground, or even pulling entire plants down into the burrow. In the west and south-

west pocket-gophers do considerable foraging on the surface at night, feeding on the leaves of various plants, but Goff found little evidence of such activity on the part of these animals in Florida. Pocket-gophers are responsible for much damage to cultivated crops. In March, 1938, citrus trees were seen in a young grove at Grand Island, Florida, which had been cleanly bitten off below the surface of the ground; one tree thus killed was two inches in diameter at the base. In several burrows which were partly dug out by Goff there were found stores of tubers, pieces of fleshy roots, and sections of stems, which in one instance were identified as stems of "Mexican clover" (*Richardia glabra*). These food stores were usually in small side chambers, but sometimes in enlarged portions of the main tunnel.

POCKET-GOPHER BURROWS AS AN ENVIRONMENT FOR ARTHROPODS

From the standpoint of their arthropod inhabitants, *Geomys* burrows constitute a biotope which shares many features of the cave environment, while possessing unique peculiarities. The burrows resemble the innermost parts of true caves in the total absence of light (except that occasionally admitted for brief periods in the vicinity of openings which are soon closed by the rodent); in the uniformly high humidity of the air, approaching saturation; in the relatively low and constant temperature (the fluctuations being slight at the depths at which the burrows lie, and from the standpoint of the inquilines being further minimized by the opportunity which the latter have to descend to lower levels if the higher passages become too warm in summer); in the absence of air movement (save for that caused by passage of the pocket gopher along its tunnels); and in the confinement and nearly complete isolation of the commensal arthropod fauna from contact with the outer world. The degree of such isolation is greatest in burrows occupied by pocket-gophers, owing to the habit these animals have of plugging all openings as soon as they are discovered. Although in the long run the obligate commensals are directly dependent upon the pocket-gopher for their existence, there is evidence that they are able to maintain themselves for considerable periods in abandoned burrows; but when a burrow is thus abandoned the exit hole of the rodent is left open, and eventually portions of the tunnel roofs may collapse, permitting gradual infiltration of geophilous and troglophilous arthropods from the outer world which mingle with and doubtless finally replace the inquilines.

Food Sources and Food Relationships

The differences between the burrow environment and that of typical caves are as striking as the resemblances. One most important point

of difference lies in the abundance of available food in the burrows, as contrasted with the meager supply in most caves. Exposed rootlets along the sides of the tunnels, the stores of roots, stems and bulbs laid up by the pocket-gopher, the grass of which the nest is composed, and fungus mycelia furnish ample quantities of living and dead vegetable food. The feces of the pocket-gopher are fed upon by various coprophagous species. Humus and decomposing organic debris constitute the basic food sources for multitudes of mites, Collembola and other minute arthropods. These and the early stages of larger insects are fed upon by small predators (small centipedes, young spiders, Staphilinid beetles, and nymphs of the "blind cricket"), which in turn, along with the larger phytophages and coprophages, are eaten by larger predators (adult spiders and the larger centipedes). The dead bodies of all the burrow inhabitants are eaten by scavengers or go to swell the organic debris which constitutes one of the basic food sources. The pocket-gopher is itself the host of internal and external parasites, the latter including a mallophagan, a flea, and probably some of the mites which swarm in the nests.

Here is a world in miniature—a world so simplified that we should eventually be able to form a clear concept of the rôles played by most of its inhabitants. In Fig. 2 an attempt has been made to analyze this biocoenose, and to indicate the principal food chains within it. This interpretation is based in part on observations made in the field, on the results of rearing some of the species, and on data obtained from colonies of the "blind crickets" established in glass-topped observation "burrows"; in part it represents more or less reliable inferences that may be drawn from what is recorded concerning the habits of related forms. In many cases almost nothing is known from which to deduce the parts played by particular species, and these have been tentatively assigned, or omitted altogether from the diagram. Species from the outer world which occasionally or regularly gain access to the burrows, particularly after their abandonment by the pocket-gopher, are also shown, and the effects of their entry are suggested by the dotted lines.

Relation of the Pocket-Gopher to the Burrow Inquilines

A second important feature of the burrow environment, which is unique and to which certain of the larger inquilines show marked adaptive responses, is the presence therein of a large animal, the pocket-gopher, whose body nearly fills the narrow tunnels, and whose digging activities and frequent comings and goings continually disturb and endanger the smaller inhabitants. Pocket-gophers are not known to eat insects, and they probably pay little attention to

the inquilines; but it behooves the latter to keep out of the rodent's way, since they are at any time likely to be buried wholesale, and the more delicately built species could be seriously injured merely by being brushed against or trodden upon.

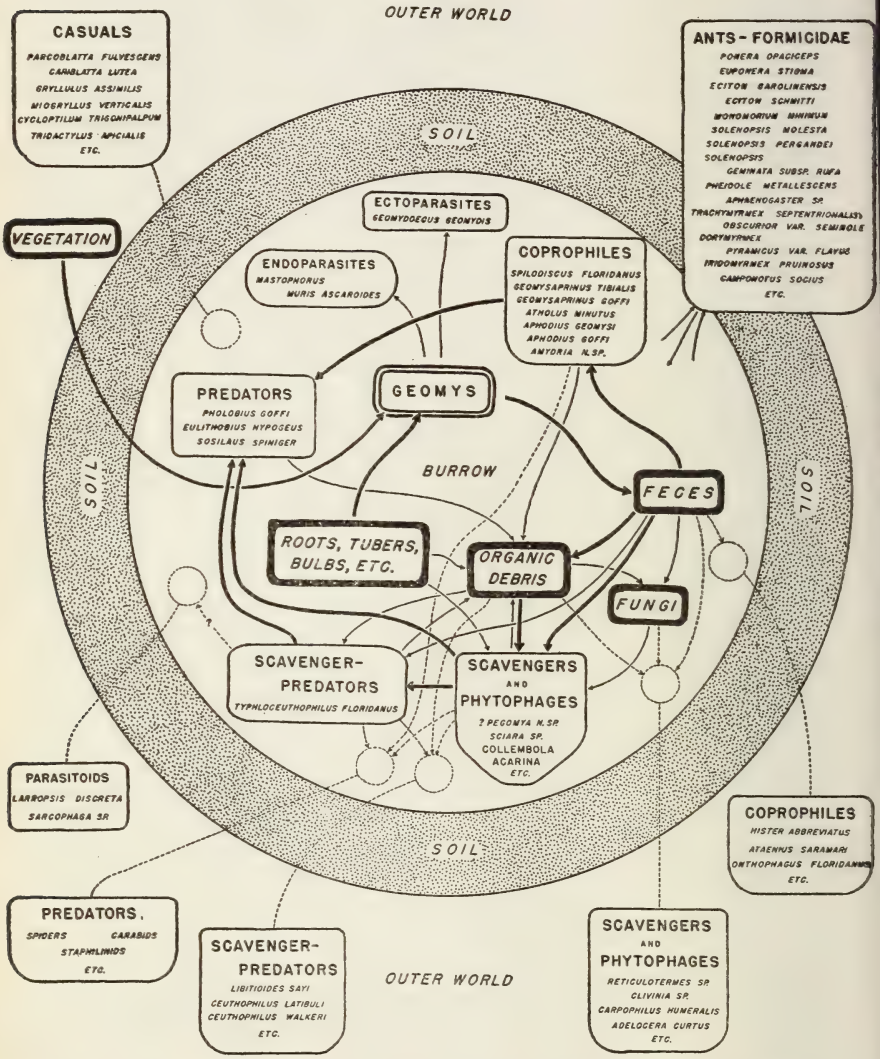

FIG. 2—Diagram suggesting the food relations within the biocoenose of the pocket-gopher burrow, and some of the effects produced by entry of species from the outer world.

The behavior of the "blind crickets," as observed in the glass-covered "burrows," is interesting in relation to this situation. By scratching in the sand at the edge of the glass cover one can simulate the slight disturbance that would normally herald the approach of of a pocket-gopher. Upon perceiving the first vibrations each "cricket" immediately stops whatever it was doing, poises motionless "on tip-toe" for an instant, and then begins to scamper rapidly about. Sometimes a few run along the burrow away from the direction of the disturbance, but the majority are ensconced in some retreat within a few seconds. Some of them disappear into the small side tunnels (the diameter of a large lead-pencil) which they have dug; others crowd their bodies into the smallest possible compass in one of the many shallow pits which they are always excavating in the walls of the burrow; still others apparently try to reach the roof of the tunnel, and failing, press their bodies horizontally into the angle between the glass and the sand. No such behavior has been noted in the related "camel- crickets" (*Ceuthophilus latibuli* and *C. walkeri*) which are often present with or in place of the "blind crickets" in burrows that have been open to the exterior; these simply run along the tunnels or hop wildly about when disturbed. The conclusion seems inescapable that the peculiar behavior of the "blind crickets" is an adaptive response to the presence of the pocket-gopher, which has arisen in the course of prolonged association with this mammal. The burrow-inhabiting moths (*Amydria* sp.) and flies (*Pegomya* sp.) are believed, on the basis of field observations, to behave in somewhat comparable fashion, flying along the burrow ahead of the advancing pocket-gopher and darting aside into lateral chambers and branches as opportunity occurs.

Degree of Isolation of the Burrows and Means of Dispersal of the Inquilines

The last major peculiarity of the burrow environment lies in the degree to which each burrow is isolated, not only from other burrows, but also from the epigeic realm. The pocket-gopher, as already noted, closes all openings into the burrow with a plug of sand. The lateral tunnels through which it carries out earth to the mounds are afterward filled up from within, often for a distance of several feet. An artificial opening into the burrow is usually found and closed within a few hours—often a few minutes—after it is made. If such an opening remains unplugged for as long as twenty-four hours the chances are that the burrow is unoccupied. Under normal circumstances, therefore, occupied burrows are in communication with the exterior only while mounds are being built (at which times

the vigorous activity of the pocket-gopher in the mouth of its tunnel must prove a deterrent to entrance or exit of other creatures), and probably sometimes at night while the rodent makes brief foraging excursions. Each burrow system is also normally isolated from those of other pocket-gophers of the same colony. This is indicated by the fact that it is very rare to trap more than one of these rodents from a single tunnel (this having happened only once during Goff's work), and also by the fact that in the burrows which were completely excavated all passages ended blindly.

How, then, is one to account for the dispersal of the inquilines from one burrow to another? For most of these species (all except the parasites) only three possible methods appear to exist: (1) to leave the burrow through one of the temporary openings made by the pocket-gopher, traverse a considerable distance above-ground, and find and enter another temporarily open burrow; (2) to leave the burrow by boring up through the soil from one of the shallower tunnels, and either to find and enter a temporarily open burrow, or by some unknown means to locate and dig down to a closed one; or (3) to spread from one burrow to another beneath the surface of the ground, by means presently to be considered. In weighing these possibilities it is necessary to bear in mind the differences that exist among the commensal species in size, means of locomotion, degree of vagility, digging powers, ability to withstand evaporation rates outside the burrow, vulnerability to outside predators, and other characteristics.

In considering the first of these possibilities, it may be noted that the adults of some of the burrow species—the beetles, flies and moths —are winged, and from their degree of sclerotization the beetles certainly and perhaps the moths and flies would be able to withstand dessication outside of the burrows for considerable periods. Furthermore, all of these insects have counterparts in the burrows of the gopher tortoise, for the inhabitants of which subterranean dispersal is obviously out of the question. It may therefore be regarded as probable that some or all of these forms may occasionally migrate from one pocket-gopher burrow to another by the first method listed above. (See the note under *Aphodius geomysi* in the annotated list). The opportunity of leaving the burrows comes only now and then, however, and the chances of finding another open burrow would appear to be rather slight—the difficulties are infinitely greater than for the inhabitants of the large-mouthed, always open burrows of the gopher tortoise. Probably only a small percentage of the individuals leaving one burrow would succeed in reaching another.

The second method suggested above would be available only to those burrow inhabitants capable of digging through several inches of soil—in other words, to the scarabaeid and histerid beetles and the "blind crickets." For reasons discussed below it is believed certain that the latter never leave the burrows voluntarily, and could not long survive were they to do so. As for the beetles, there is no evidence either for or against their dispersal in this way, but on the whole this seems the least feasible of the methods considered.

The precarious undertaking of leaving one burrow and finding the evanescent opening to another might occasionally succeed in the case of the insects mentioned above, but would be very nearly impossible of accomplishment by other obligate inquilines, which are characterized by some or all of the following disabilities for such dispersal—small size and feeble powers of locomotion, absence of wings, and inability to withstand dessication in air which falls significantly below saturation. The "blind crickets" possess moderate vagility, but only under rare circumstances could they survive long enough outside the burrows to have any chance of finding the opening of another. Some of them left in the laboratory at Leesburg overnight in a glass jar containing moistened food and with a screen cover were all dead and shrivelled up the next morning, even though the night had been humid. Furthermore, these and some of the other burrow insects have been observed to exhibit a strongly negative reaction to air currents and increased evaporation rates. The moths, flies and "blind crickets" retreat from openings made into the natural burrows, and even during the night seldom enter trap-pits that have not been tightly covered. During an entire week a small tunnel was left open from one of the glass-topped observation "burrows" to the outside; although this "burrow" was in a dark, enclosed, fairly moist space beneath a house, and contained a fair-sized colony of the "blind crickets," not a single individual took advantage of the opportunity to escape.

It seems quite improbable that the "blind crickets," centipedes, Collembola and other delicate inquilines ever voluntarily leave the burrows. We are therefore forced to seek some means whereby these (and consequently the beetles, flies and moths, as well) may normally be transferred from one burrow to another underground. Another class of observations also leads to the same conclusion. If dispersal of the burrow fauna were primarily dependent upon epigeic migration, the low percentage of survival of the migrants and the chances that exist against a majority of the species reaching any particular burrow would lead one to expect that many burrows would

be found with only a small and variable representation of the entire fauna, and that the species most often present would be those best fitted for epigeic dispersal. This appears not to be the case; on the contrary, most burrows examined were found to contain a high proportion of the characteristic species, large and small, vagile and the reverse.

In the light of the above considerations, we are of the opinion that dispersal of the burrow fauna occurs chiefly beneath the surface of the ground, through connections temporarily established between adjacent burrows. Three possible means of such transfer are suggested by what is known of the habits of *Geomys*. (1) When they encounter the tunnels of other individuals, pocket-gophers apparently make use of them for disposal of sand. In carrying earth into the neighboring burrow they may transport with it small arthropods and the eggs or larvae of larger forms, and at the same time are likely to herd before them some of the more active adult insects, such as the "blind crickets," moths and flies. (2) As noted above, a tunnel abandoned by one pocket-gopher may be found and brought into use by another individual after a longer or shorter interval of time. If the discovery takes place while the commensal fauna is still more or less intact, this results in transfer of the species present *en bloc* from one burrow system to another. How long the burrow fauna may survive after abandonment of the burrow by its maker is not known, but the period probably varies from some months to one or more years, depending upon circumstances. (3) According to Crouch (*op. cit.*, p. 9) temporary connections are established between the burrow systems of male and female pocket-gophers during the breeding period, and it is quite probable that this is the usual means by which spread of the inquilines is brought about.

METHODS OF COLLECTING AND STUDYING THE ARTHROPODS OF THE BURROWS

Since an inexperienced person may waste much time and effort in unsuccessful attempts to locate *Geomys* burrows, we here describe a method by which, with a little practice, one can find the tunnel about once in every two or three trials. Locating a group of mounds, their arrangement is inspected to estimate the probable course of the main burrow (see Fig. 1). Then, selecting one of the fresher mounds, the sand is scraped off level with the ground. Somewhere on the surface thus exposed there will usually appear an area of lighter-colored sand than the rest; this is the plug of subsurface soil filling the lateral tunnel that led to the mound. Digging back

along this plug with a trowel, or preferably a light trenching spade, its course can usually be traced without difficulty until it enters the light-colored subsurface soil. From this point on it is harder to follow because the contrast in color between the plug and the surrounding soil is lost. At this stage of the work it is often helpful to test the firmness of the sand on the face of the excavation by pressing it with the finger; the plug is usually less compact than the undisturbed soil around it. If the plug can be traced it will eventually lead to an open burrow; but if it makes a sudden turn to one side or downward it may easily be lost. Even when this has happened the open burrow can often be found by digging a few feet further in the same general direction, and deepening the trench to two to three feet. If this fails, time is usually saved by trying another mound.

A second method which has been recommended for locating the burrow consists in estimating its probable course by the arrangement of the surface mounds, and probing for it with a special tool. A satisfactory probe can be made from a broom-, hoe- or shovel-handle, bluntly pointed at the end, and with a foot-rest attached about 18 inches from the point. Crouch (*op. cit.*, p. 12) gives directions for making a more permanent instrument from pipe and pipe fittings. The probe is repeatedly thrust into the ground with the foot, at short intervals along a line which should intersect the burrow, until its point is felt to enter the tunnel. This method is less laborious than that described above, but Goff has had less success with it.

The burrow located, it is necessary to set traps for the pocket-gopher, whether one wishes to excavate the burrow or merely to trap the inquilines. If the animal is left in residence it will plug the burrow ahead of the excavator, and it will fill trap-pits and bury trap-jars as fast as it finds them. A combination trap-set designed to capture both the pocket-gopher and its arthropod guests is generally employed. The hole intersecting the burrow is enlarged until the ends of the tunnel open squarely into it and there is space at the bottom for one or more trap-jars. The pit should not, however, be made larger than necessary, for it must later be covered tightly with paper. If a trench leads into one side of the pit it should be filled up level with the ground to complete the pit-wall.

In each of the tunnel-mouths a pocket-gopher trap is set, and firmly staked or tethered if the trap is so constructed that it might be dragged back into the burrow. We have used both the piercing-jaw type of trap described and figured by Crouch (*op. cit.*, p. 16)

and a wire-loop type devised by Dr. H. B. Sherman, and have found them about equally effective. Both are sprung by the pocket-gopher when it tries to plug the opening, and both leave the entrances to the tunnel unobstructed, so that arthropods can enter the trap-pit. For the mammalogist the wire-loop trap has the advantage that it does not seriously damage the pocket-gopher as a specimen.

Pint or tall half-pint glass jars with slightly incurved rims were found to make the best traps for the burrow arthropods. Dilute blackstrap molasses, poured in the jar to a depth of half an inch, proved so attractive a bait that in most of our work we used no other. Unbaited jars caught very few specimens in comparison with baited ones. (It would be interesting to experiment with other baits, such as meat, or feces of pocket gophers, etc.).[19] One or more baited jars are buried to the brim in the floor of the trap-pit. The edges of the pit are then smoothed off and the top is covered with a piece of heavy wrapping paper or with several thicknesses of newspaper, around the edges of which sand is heaped. This precaution is necessary, both to exclude epigeic insects which would otherwise be attracted to the traps, and to keep the air within the trap-pit moist and still like that in the burrows. Experience has shown that very few of the burrow-inhabitants will enter the trap-pits if they are left uncovered. With the greatest care an occasional arthropod from outside gains access to the jars, and the catch must always be critically examined with this possibility in mind.

The traps should, if possible, be inspected at least every twenty-four hours and the specimens removed, since the more delicate of the burrow species disintegrate very rapidly after death. A single trap may continue to capture specimens for a week or more, though the bulk of the catch is made in the first two or three days. The insects and other forms taken from the molasses should be thoroughly washed in water and preserved in 80% alcohol, from which the more heavily sclerotized can later be pinned if desired. Even some of the more delicate insects will make good dried specimens by use of the xylol technique.[20]

The moths and flies caught in molasses traps are almost useless as specimens; to be identifiable, specimens of these groups must be captured and killed in cyanide jars for pinning, or obtained by rear-

[19]For additional suggestions concerning techniques that may prove useful, see the papers cited in footnotes 8, 9, 10, and the following paper: Barber, H. S. "Traps for cave-inhabiting insects." *Journ. Elisha Mitchell Sci. Soc.*, Chapel Hill, N. C., Vol. 46 (1931), pp. 259-66, 1 pl., 1 fig.

[20]Described by Hubbell, pp. 13-14 of the reference cited in footnote 7.

ing larvae. Even in the case of the other groups of inquilines, specimens found during excavation of the burrows and placed directly in alcohol or killed in cyanide jars are better preserved than those obtained by trapping. It is very difficult to obtain series in this way, however, and many of the smaller forms escape notice altogether. Relatively few specimens are usually encountered when only a portion of a burrow system is uncovered. In the two burrows which Goff traced in their entirety, most of the larger and more active arthropods were found near the closed ends of the tunnels, to which they had retreated as the work progressed. It is therefore advisable, if a portion of a burrow is to be dug out in search of arthropods, to locate the tunnel at two points, and to close one end of the section before starting to dig at the other, in order to prevent escape of a large share of the occupants.

If their food materials can be determined, many of the burrow arthropods can doubtless be reared in "lamp-chimney" type cages, set in moist sand with the tops covered with glass plates to keep the air inside sufficiently moist. A colony of the "blind-crickets" has been maintained for 30 months in an artificial "burrow" consisting of a wooden box about four inches deep, filled with moist sand in which is scooped a shallow tunnel, the whole surface of the sand being covered by a glass plate which forms the roof of the tunnel. Two holes drilled in the glass above the "burrow" permit introduction of food and are kept covered with small pieces of glass. The "blind-crickets" seem to require very little food, but this is probably the result of the presence in the "burrow" of flourishing populations of two species of Collembola, upon which they appear to feed.

ANNOTATED LIST OF THE INVERTEBRATES FOUND IN *GEOMYS* BURROWS

Although nearly eighty species of insects and other arthropods have been collected in pocket-gopher burrows in Florida (largely by trapping), many of these are common out-door forms that either fell unnoticed into the excavations or were able to creep under the covers of the trap-pits. We have eliminated from consideration such as obviously belong to this category. Of the remaining sixty-one invertebrate species listed below (all arthropods except the roundworm *Mastophorus m. ascaroides*), fifteen of the arthropods are believed to be obligate inquilines that constitute the true burrow fauna so far as this has been determined. These pholobiont species are indicated by stars in the list. All the other species are listed as "casuals," although a number of them were doubtless accidentally

introduced. By a "casual" is meant a species that may sometimes, or even quite regularly, find its way into pocket-gopher burrows, but which has no obligatory relation to the pocket-gopher, and which would probably be incapable of maintaining itself indefinitely in the burrow environment. The presence of some of these "casual" species is evidently the result of their burrowing habits; in the case of the majority it probably indicates that the burrow in which they were found had at some fairly recent time been open to the outside for an appreciable period.

To conserve space we give here the exact localities and the collectors' names for all lots of material reported in this paper, and omit county and collector in the annotated list. In recording the material, however, all dates of capture are noted, since these roughly indicate the number of burrows in which each species was found.

List of Florida Localities in which Arthropods were collected from *Geomys* Burrows

Dade City, Pasco County: T. H. Hubbell.

Devil's Millhopper, approximately 7 miles northwest of Gainesville, Alachua County: H. K. Wallace.

Dug Creek, a small affluent of the Little Manatee River near the bridge on U. S. Highway No. 41, Hillsborough County: C. C. Goff, T. H. Hubbell and J. J. Friauf.

Eau Gallie, Brevard County: C. C. Goff, T. H. Hubbell and J. J. Friauf.

Gainesville, Alachua County: H. K. Wallace in 1938, B. A. Barrington in 1939 and 1940.

Glenwood, Putnam County: C. C. Goff, T. H. Hubbell and J. J. Friauf.

Lake Streaty, about 5 miles south of Frostproof, Polk County: C. C. Goff, T. H. Hubbell and J. J. Friauf.

Leesburg and vicinity, Lake County: C. C. Goff.

Marianna, Jackson County: C. C. Goff.

Melrose, Putnam County: B. A. Barrington.

Newnan's Lake, (an area about 1 mile west of the lake and about 4 miles east of Gainesville), Alachua County: H. K. Wallace in 1938, B. A. Barrington in 1939 and 1940.

St. Cloud, Osceola County: C. C. Goff, T. H. Hubbell and J. J. Friauf.

San Mateo, Putnam County: C. C. Goff, T. H. Hubbell and J. J. Friauf.

Tavares, Lake County: C. C. Goff.
Waukeenah, Jefferson County: C. C. Goff.
Welaka, Putnam County: J. J. Friauf.

NEMATHELMINTHES

Mastophorus muris ascaroides (Gmelin) Chitwood

Internal parasite of *Geomys*. Leesburg, Nov. 24, 1938, a large number in stomach of large female *Geomys*. Also found in *Geomys* stomachs at Leesburg and elsewhere on several other occasions. Determined by J. T. Lucker.

CHILOPODA

LITHOBIIDAE

**Eulithobius hypogeus* n. sp., Chamberlin[21]

Obligate; predator. Newnan's Lake, June 28, July 2, 1938, 3 specimens in two burrows; Nov. 13, 1939, 1 specimen; Devil's Millhopper, Aug. 6, 1938, 1 specimen; Melrose, Aug. 2, 1939, 1 specimen. This is the larger of the two species of centipedes found in the burrows. According to Dr. Chamberlin it is a very distinct form, and the only member of the genus *Eulithobius* (as now restricted) known from the United States.

**Pholobius goffi* n. gen. et sp., *Chamberlin*[21]

Obligate; predator. Leesburg, Twp. 19 S., R. 25 E., Sect. 19 (type locality), March 21, 1938. 1 male, the holotype and only known specimen.

ARACHNIDA

ACARINA

IXODIDAE

Amblyomma sp.

Parasite. Newnan's Lake, Dec. 9, 1939, many specimens on male *Geomys*. Determined by R. A. Cooley.

Ticks were found on only a single one of the many pocket-gophers examined. Dr. Cooley states that these specimens are all nymphs, and hence cannot be determined to species. The only species of *Amblyomma* known from Florida are *A. cajennense* and *A. tubercu-*

[21]Chamberlin, R. V., "Two new Lithobiid Chilopods from Burrows of the Florida Pocket Gopher," *Ent. News*, Vol. 51 (1940), pp. 48-50. *Eulithobius hypogeus* is described on p. 48, *Pholobius goffi* on p. 49.

latum; Dr. Cooley writes that "these are not *cajennense,* and it is hard to believe that they are *tuberculatum,* which is found on reptiles and toads" (and also on the gopher frog).

PARASITIDAE

Macrocheles sp.

Casual?; symbiont with insects. Leesburg, April 19, 1938, 1 specimen. Determined by H. E. Ewing.

Parasites. Mites of the family Parasitidae were found swarming in the grass nest of a *Geomys* at Leesburg, in April, 1928. Since *Atricholaelaps glasgowi* (Ewing) (determined by H. E. Ewing) is abundant in the nests of *Peromyscus polionotus* at Leesburg (many specimens taken Dec. 11, 1938), and occurs on a variety of mammals, particularly rodents, it is not unlikely that this was the species represented in the *Geomys* burrow. Other Parasitid mites were found on several specimens of the scarabaeid beetle *Aphodius goffi.*

Phytophages (Tyroglyphidae) and predators (Bdellidae) were found at Leesburg on various occasions, in food chambers and crawling in the burrow.

OPILIONES

Libitioides sayi (Simon)

Casual; scavenger-predator? Leesburg, July 7, 1938, 1 specimen. Determined by T. H. Hubbell.

Common in Florida under objects lying on the ground, among dead leaves and beneath the loose bark of logs. Formerly placed in the genus *Cynorta.*

ARANEAE

LYCOSIDAE

**Sosilaus spiniger* Simon

Obligate; predator. Leesburg, April 13, 15, June 23, 25, July 7, 1938, 5 males, 8 females, 2 juveniles (the latter taken July 7); Dug Creek, Aug. 15, 16, 1938, 1 male, 1 female; Newnan's Lake, June 28, July 2, 6, 1938, 1 male, 4 females, 3 juveniles. Determined by H. K. Wallace.

This remarkable spider, described from Louisiana in 1898, has remained one of the rarest and least known of American Lycosids until the work on *Geomys* burrows showed it to be of frequent occurrence therein. It is believed to be confined to these burrows, though it is possible that it may also occur in those of the gopher tortoise. The pale coloration and delicate structure are unusual for

a Lycosid, and Dr. Wallace informs us that specimens from two of the Leesburg burrows have the eyes much reduced—facts which indicate that the species is a true pholobiont.

Casuals. One large Attid, a Salticid, and several other small spiders were found in an abandoned burrow at Leesburg.

INSECTA

THYSANURA

LEPISMATIDAE

**Nicoletia* n. sp.

Obligate (or soil-inhabitant?). Three males were taken in a *Geomys* burrow near Newnan's Lake, Dec. 18 and 20, 1939. Dr. H. B. Mills is describing the species in an early number of *Entomological News*. This slender, wingless insect is approximately 7 mm. long, exclusive of the antennae and the three caudal filaments; it is blind, and white in color except for a faint tinge of brownish on the dorsum. The most striking peculiarity lies in the modification of the 4th abdominal tergite, which is enlarged and somewhat elevated above the succeeding segments, and bears on its dorsal surface a flattened median sclerotized area with arcuate cephalic margin and with its posterior margin truncated by the caudal edge of the tergite. It is uncertain whether this peculiar development of the fourth abdominal tergite is a secondary sexual characteristic of the males or not, since the females are unknown.

COLLEMBOLA

ENTOMOBRYIDAE

Pseudosinella violenta Folsom

Casual; soil-inhabiting saprophage, phytophage, scavenger. Melrose, Aug. 3, 1938, 1 specimen; Devil's Millhopper, July 6, 1938,

This springtail is sometimes quite abundant in the burrows. It is a large species, white, or whitish with faint blue-gray markings.

Lepidocyrtus cyaneus Tullberg

1 specimen; Leesburg, April 19, 1938, 6 specimens. Determined by H. B. Mills.

Casual; soil-inhabiting saprophage, phytophage, scavenger. Newnan's Lake, Oct. 15, 1939, numerous specimens. Determined by H. B. Mills.

Found in great abundance in a few burrows; a small steel-blue species.

We are informed by Mr. B. A. Barrington that when the soil is relatively dry after long rainless periods Collembola may be trapped from the burrows in numbers by using trap-jars containing a little water; following rains few or no specimens are taken by this method.

ORTHOPTERA

BLATTIDAE

Cariblatta lutea (Saussure and Zehntner)

Casual; scavenger, omniphage. Leesburg, April 15, July 7, 1938; Dug Creek, Aug. 16, 1938. Determined by T. H. Hubbell.

This small ground-dwelling cockroach is extremely abundant throughout Florida. Since the specimens taken in the burrows were all immature or females, racial determination could not be made; doubtless both *lutea lutea* and *lutea minima* Hebard frequently enter abandoned burrows.

Parcoblatta fulvescens (Saussure and Zehntner)

Casual; scavenger, omniphage. Newnan's lake, June 24, 28, July 6, 1938; Glenwood, July 29, 1938; Leesburg, June 21, July 7, 1938; Lake Streaty, Aug. 10, 1938; Dug Creek, Aug. 16, 1938. Determined by T. H. Hubbell.

Like the preceding, this cockroach is very common among dead leaves, under logs, beneath loose bark, and wandering about at night in pinelands, hammocks, turkey oak and sand scrub habitats throughout the state. All of the specimens recorded above were immature except one female taken at Newnan's Lake, June 24th, and another female from Lake Streaty.

GRYLLACRIDIDAE

Rhaphidophorinae

Ceuthophilus latibuli Scudder

Casual; scavenger-predator. Gainesville, June 24, 1938; Newnan's Lake, June 20, 24, 1938; Glenwood, July 29, 1938; Tavares, March 20, 1938; Leesburg, March 20, 21, 28, 29, 30, April 1, June 11, 23, 25, 27, 30, July 7, 1938; Eau Gallie, May 1, 1938; St. Cloud, Aug. 6, 1938; a total of approximately 60 specimens in all instars, taken in about 14 burrows. Determined by T. H. Hubbell.

This, the commonest "camel-cricket" occurring in Florida, is often found in gopher tortoise burrows and is frequently cited as a commensal of that reptile. In reality the species is a troglophilous form of wide ecologic valence, abundant in turkey oak and sand scrub habitats and elsewhere; often digging small burrows for itself in

sandy soils, but also taking shelter in limestone caves, burrows and similar refuges. It is one of the most frequent of the casuals found in *Geomys* burrows. It has been found in association with *Typhloceuthophilus* in six burrows, but ordinarily when one of these species is present the other is not found. The species has been fully discussed by Hubbell (*op. cit.*,[7] pp. 324-33).

Ceuthophilus walkeri Hubbell

Casual; scavenger-predator. Newnan's Lake (type locality), June 24, 1938, 2 juvenile males in one burrow; Dec. 16, 1939, 1 male; Dec. 18, 1939, 1 female. Determined by T. H. Hubbell.

This "camel-cricket" is similar in habits to the last, though less common and more characteristic of high-pine situations. It is occasionally found in the burrows of *Gopherus polyphemus*. The species has been fully discussed by Hubbell (*op. cit.*,[7] pp. 394-6).

**Typhloceuthophilus floridanus* n. gen. et sp., Hubbell

Obligate; scavenger-predator. Melrose, Aug. 2, 1939, 1 juvenile male; Gainesville, June 28, July 6, 1938, 1 male, 1 juvenile female; Newnan's Lake, June 20 to July 6, 1938, 26 small to large juveniles; Devil's Millhopper, July 6, 1938, 12 juveniles; Leesburg (type locality) and vicinity, March 21, 28, 30, 31, April 1, 15, 19-22, May 8, June 11, 20, 23, 25, 27, 30, July 7, 1938, 49 males, 52 females, 184 juveniles, not including about 100 additional individuals kept alive in observation burrows or watched in the field, and not preserved as specimens; Tavares, Feb. 12, 1938, 1 juvenile male; Dade City, April 9, 1938, 1 juvenile male; St. Cloud, Aug. 6, 1938, 3 males, 1 female, 8 juveniles; Eau Gallie, May 1, 1938, 2 males, 1 female, 5 juveniles; Aug. 7-9, 1938, 18 juveniles.

This is the "blind cricket" referred to throughout this paper. It is one of the commonest of the obligate commensals. The description of this species appeared recently, in a paper[12] which includes a detailed account of its life history, habits and mode of existence in the burrows. The insect can be distinguished from all previously known North American Rhaphidophorinae by having the tarsi of all legs three-segmented (at least the middle tarsi in all the rest being four-segmented), and by the complete absence of pigmentation in the ocular region; it is the first completely blind Rhaphidophorid to be made known.

GRYLLIDAE

Gryllulus assimilis (Fabricius)

Casual; scavenger, omniphage. St. Cloud, Aug. 6, 1938, 1 juvenile. Determined by T. H. Hubbell.

This is the common field cricket, abundant throughout Florida. It probably occasionally enters abandoned burrows.

Miogryllus verticalis (Serville)

Casual; scavenger, omniphage. Newnan's Lake, July 6, 1938, 1 female; Leesburg, March 21, April 1, 1938, 2 juvenile males (one with *Typhloceuthophilus*); Lake Streaty, Aug. 10, 1938, 1 male. Determined by T. H. Hubbell.

Similar in habits to the last, but more of a burrower.

Cycloptilum trigonipalpum (Rehn and Hebard)

Casual; omnivore? St. Cloud, Aug. 6, 1938, 1 male. Determined by T. H. Hubbell.

This small scaly cricket is common on the foliage of trees and especially of shrubbery, in trash and forest debris on the ground, and beneath loose bark. It seeks concealment under cover during the day, and probably now and then enters an unused *Geomys* burrow. Its occurrence in this burrow may, however, have been due to accidental introduction.

TRIDACTYLIDAE

Tridactylus apicialis Say

Accidental or casual; omnivore? St. Cloud, Aug. 6, 1938, 1 specimen. Determined by T. H. Hubbell.

Only two species of Tridactylidae ("pygmy mole-crickets") are known from North America, this being the larger of the two. These minute insects make shallow burrows in moist sandy soil, and are usually encountered along the margins of streams and ponds, or about seepage areas. We were greatly surprised to find *T. apicialis* in this burrow; and while the insect is certainly not a regular burrow-inhabitant and may not even be a casual entrant, we include the record on other counts. The species was described by Say in 1825 from "the St. John's River in East Florida," and this remains the only published record of its occurrence in the state. The species has hitherto been taken by Hubbell only in Liberty, Gadsden, Jefferson and Marion counties, and is evidently much less common in Florida than *T. minutus*, which is everywhere abundant. St. Cloud is the southeasternmost known locality for the species. It is also of interest that the burrow in which this specimen was found was situated in a dry turkey oak grove far from water—a very unexpected type of habitat for the species.

ISOPTERA

Reticulotermes sp.?

Casual; xylophage. Newnan's Lake, Dec. 18, 1939, 1 dealate queen, determined by T. H. Hubbell; Leesburg, March 28, April 15, 1938, numerous workers in three burrows, determined by H. R. Johnson.

Concerning the workers from Leesburg, Mr. Johnson noted: "head dark brown, unusual, interesting; soldiers needed to make definite determination." No specimens of the soldier caste of this termite were encountered in the burrows. The dealate queen from Newnan's Lake is unusually dark brown, but otherwise does not differ from specimens which emerged from a colony of *Reticulotermes flavipes* Koll. in a house in Gainesville.

MALLOPHAGA

**Geomydoecus geomydis* Osborn

Obligate; external parasite on *Geomys*. Marianna, April 23, 1938, many specimens; Leesburg, March 28, April 1, 14, 1938, many specimens. Determined by J. Bequaert.

Pocket-gophers are often heavily infested with this biting-louse, which is confined to this single host.

HEMIPTERA

CYDNIDAE

Pangaeus bilineatus Say?

Casual: phytophage, sucking roots? Leesburg, March 30, June 11, 1938, 2 specimens, both immature. Determined by T. H. Hubbell.

The bugs of this family are burrowers, and are believed to feed largely on roots. These specimens may possibly have been accidentally introduced in digging the trap-pit.

COLEOPTERA

CARABIDAE

Clivinia sp.

Casual; probably predator and phytophage. Leesburg, May 5, 1938, 1 specimen. Determined by L. L. Buchanon.

May have been accidentally introduced. A plant feeder in part; but nearly all of the ground-beetles are more or less carnassial, and the structure of the mandibles of *Clivinia* indicates that it is a facultative predator.

LEIODIDAE

Ptomophagus sp. near *consobrinus* (LeConte)

Casual or obligate?; trash-feeder in nests? Newnan's Lake, Nov. 13, 1939, several specimens. Determined by F. N. Young.

It is probably no accident that this small beetle was taken in a *Geomys* burrow, for Hubbard recorded *P. consobrinus* and *P. ulkei* from burrows of the gopher tortoise in Florida[3] and *P. fisus* from burrows of jumping mice and from the grass nests in spermophile holes in southern California.[4] According to Mr. Young the specimens from *Geomys* burrows do not agree in all respects with the description of *P. consobrinus;* they are, however, either that species or a very closely allied form.

STAPHYLINIDAE

Genus near *Atheta*

Casual or obligate?; probably a fungus-feeder, perhaps a predator. Leesburg, April 15, 1938, 1 specimen in burrow near nest. Determined by E. A. Chapin.

Another small Staphylinid beetle which superficially resembles *Atheta* was collected at Welaka, Nov. 22-24, 1939, in molasses trap in burrow. Goff's records mention other specimens of this family taken at Leesburg, but the specimens cannot be found. Barrington has taken at least three species of Staphylinidae different from any of the above in burrows at Newnan's Lake.

HISTERIDAE

Histrinae

**Spilodiscus floridanus* n. sp., Ross[22]

Obligate; coprophilous predator. Leesburg (type locality), April 15, 1938, 4 specimens (holotype and paratypes); Newnan's Lake, June 22, 1938, 1 specimen (paratype).

This is the largest Histerid found in the burrow. According to Mr. Ross it is related to *S. gloveri* Horn, described from Oklahoma and not since encountered; this suggests that *gloveri* may likewise be an inhabitant of mammal burrows and that this may account for its apparent rarity.

[22]These new beetles are described in a recent paper by E. S. Ross, "New Histeridae (Coleoptera) from the burrows of the Florida pocket gopher," *Ann. Ent. Soc. Amer.,* Vol. 33 (1940), pp. 1-9, figs. 1-5.

Hister abbreviatus Fabricius

Casual; coprophilous predator. Lake Streaty, Aug. 10, 1938, 1 female. Determined by E. S. Ross.

This species is common under cow-dung almost throughout the United States.

**Atholus minutus* n. sp., Ross[22]

Obligate; coprophilous predator. Leesburg (type locality), April 15, 1938, 1 female, the holotype.

Mr. Ross states that the small size (length only 2.25 mm.) and narrow outline of this insect distinguish it from all other *Atholus* of the North American fauna. It is as yet known only from the type.

Saprininae

**Geomysaprinus goffi* n. gen. et sp.. Ross[22]

Obligate; coprophilous predator. Gainesville, June 23, 1938; Newnan's Lake, June 16, 20, 21, 22, 24, July 2, 1938; Melrose, July, 1939; Leesburg (type locality), March 28, 29, April 1, 15, May 8, July 7, 1938; St. Cloud, Aug. 8, 1938; Eau Gallie, May 1, Aug. 8, 1938; Dug Creek, Aug. 15, 1938; a total of 34 males and 37 females (holotype and paratypes).

This is the commonest of the Histerids found in the burrows; it averages about 4 mm. in length by 3 mm. in breadth. It is the genotype of the distinctive new genus *Geomysaprinus,* which is allied to *Chelyoxenus* Hubbard. Mr. Ross writes: "It is of interest to note that all the species of Saprininae of our fauna which possess entire humeral elytral striae (a primitive condition) fall in genera, the species of which are apparently confined to the burrows of certain animals: e. g., *Chelyoxenus* Hubbard, *Eremosaprinus* Ross and *Geomysaprinus* n. gen."

**Geomysaprinus tibialis* n. sp., Ross[22]

Obligate; coprophilous predator. Eau Gallie (type locality), May 1, 1938; Leesburg, August 15, 1938; Lake Streaty, Aug. 10, 1938; a total of 5 specimens (holotype, two male paratypes, and two female specimens from Leesburg not designated paratypes because not taken with males).

This species, found in the same burrows as *G. goffi* in the central part of the state, is not known north of Leesburg. It can readily be separated from *goffi* by its much smaller size (length 3 mm.), broad circular form, and the entire sutural striae of the elytra, and in the case of the males by differences in the structure of the cephalic tibiae.

ELATERIDAE

Adelocera (or *Lacon*) *curtus* (LeConte)

Casual; phytophage? Newnan's Lake, July 6, 1938, 1 specimen. Determined by E. D. Quirsfeld.

Perhaps accidentally introduced; but this and the next species are frequently found in trash on the ground, and may enter abandoned *Geomys* burrows for shelter.

Melanotus clandestinus (Erichson)

Casual; phytophage. Same data and remarks as last. A very common and widespread species.

NITIDULIDAE

Carpophilus humeralis (Fabricius)

Accidental or casual; sap-feeder, etc. Leesburg, June 11, July 7, 1938, and other localities; numerous specimens. Determined by H. C. Fall.

This introduced Old World species is abundant in Florida, occurring on decaying fruit, about fermenting sap, and on other juicy decaying vegetable substances. The species was probably attracted to the traps from outside by the odor of the molasses bait, but it is difficult to account for its entry in numbers when the trap-pits were so tightly covered that few other out-door species were able to gain access to them.

SCARABAEIDAE

Coprinae

Onthophagus floridanus Blatchley

Casual; coprophage. Leesburg, June 21, 1938, 1 specimen. Determined by O. L. Cartwright.

APHODIINAE

**Aphodius goffi* n. sp., Cartwright[23]

Obligate; coprophage. Newnan's Lake, June 24, July 2, 1938; Welaka, Nov. 22-24, 1939, 2 specimens (new record); Leesburg, March 31, June 11, 15, 1938; Eau Gallie (type locality), May 1, 1938; Dug Creek, Aug. 15, 16, 1938; a total of 67 specimens. We-

[23]Cartwright, O. L. "Eleven New American Coleoptera (Scarabaeidae, Cicindelidae)." *Ann. Ent. Soc. Amer.*, Vol. 32 (1939), pp. 353-64, 1 fig. *Aphodius goffi* is described on p. 354, *A. geomysae* on p. 356, and *Ataenius saramari* on p. 360, from material recorded in the present paper.

laka specimens determined by T. H. Hubbell, remainder types and paratypes.

This is much the larger of the two species of *Aphodius* found in the burrows, and equals in size any other member of the genus occurring in Florida.

**Aphodius geomysi* n. sp., Cartwright[23]

Obligate; coprophage. Marianna, June 23, 1938; Newnan's Lake (type locality), June 24, 28, July 2, 1938; Gainesville, July 6, 1938; Melrose, Aug. 2, 1939, 2 specimens (new record); Welaka, Nov. 22-24, 1939, 1 specimen (new record); Eau Gallie, May 1, Aug. 8, 9; Lake Streaty, Aug. 10, 1938; a total of 72 specimens, all part of the typical series except those from Melrose and Welaka, which were determined by T. H. Hubbell.

This and the preceding are among the commonest of the obligate inquilines. *A. geomysi* apparently sometimes leaves the burrows, as two specimens recorded by Cartwright were taken in ordinary collecting on August 21, 1922 and March 18, 1923, at Gainesville, very likely under street-lights.

Ataenius saramari n. sp., Cartwright[23]

Casual?; coprophage. St. Cloud (type locality), Aug. 8, 1938, 1 specimen, the holotype.

The species of this genus feed upon dung and fungi, and are frequently found beneath objects lying on the ground, and in piles of debris. *A. saramari* is probably not an obligate, and may even have been accidentally introduced.

Melolonthinae

Diplotaxis bidentata LeConte

Casual; phytophage. Leesburg, March 29, April 15, 1938, 2 specimens; Eau Gallie, May 1, 1938, 1 specimen. Determined by O. L. Cartwright.

This common phyllophagous species is certainly not a regular inhabitant of the burrows. It may occasionally seek shelter in open burrows, or it may have accidentally emerged in these burrows in digging up from its pupal chamber.

LEPIDOPTERA

TINEIDAE

Tineinae

**Amydria* n. sp.

Obligate; coprophage or possibly feeding on shed *Geomys* hair in larval stage. Newnan's Lake, July 2, 1938, 3 adults; Leesburg, May

8, June 8, 1938, many adults and larvae; also seen in other burrows at Leesburg and in a few other localities. Determined by August Busck.

These small, dull-colored moths are quite numerous in some of the burrows, but are hard to capture. Adults come to molasses traps, but those caught in this way are valueless as specimens. Larvae were found in abundance on pocket-gopher dung in one burrow, and some were reared to maturity in the laboratory on this food. However, in another burrow studied no feces were found, yet adult moths were present, and larvae which seemed identical with those reared on the dung were present in the grass nest. Since the moth belongs to the same group as the common clothes moth, which feeds on wool and other animal substances, it is possible that the larvae in this nest were not feeding on the grass, but on scurf and shed hairs from the skin of the pocket-gopher. It is of interest that in California Hubbard[4] found a small Tineid moth similar to the clothes moth continually coming up out of the burrows of the kangaroo rat as they were excavated; the moths were also found in spermophile burrows, and it is implied that the larvae were found feeding upon pellets of spermophile dung.

DIPTERA

CECIDOMYIIDAE

Genus near *Diplosis*

Casual?; phytophage in larval stages. Leesburg, April 15, 1938, 1 specimen. Determined by C. T. Greene.

This gall-midge may have emerged from some of the roots or other plant parts brought into the burrow by the pocket-gopher, or it may live upon fungi or the food stores of the rodent and be a part of the true burrow fauna.

SCIARIDAE

Sciara sp.

Casual?; phytophage (fungus-feeder) in larval stages. Waukeenah, April 24, 1938, 2 females. Determined by Alan Stone.

According to Mr. Stone, these fungus-gnats cannot be determined from the female, but the species falls into an interesting group. The larvae of this family feed on fungus mycelia in damp places, and it is possible that this species may be a member of the true burrow fauna.

STRATIOMYIIDAE

Casual?; parasite or necrophage. Mr. B. A. Barrington has recently reared a species of this family from the rectum of a pocket-gopher; he will report fully upon this occurrence in a later publication.

OTITIDAE

Acrosticta apicalis Williston

Casual?; phytophage in larval stages. Eau Gallie, Aug. 8, 1938, 1 specimen. Determined by C. T. Greene.

The larvae of some species of this family breed in bulbs, and others have been reared from decaying plant materials. This pictured-wing fly may have emerged from bulbs, roots or other plant parts stored by the pocket-gopher; it is probably not a true inquiline.

ANTHOMYIIDAE

Anthomyiinae

**Pegomya* sp., probably new

Obligate; coprophage or phytophage in larval stages. Waukeenah, April 24, 1938; Newnan's Lake, Dec. 3, 1939; Melrose, Aug. 3, 1939; San Mateo, July 30, 1938; Welaka, Nov. 22-24, 1938; Leesburg, March 28, 30, 31, April 1, 15, 1938; St. Cloud, Aug. 8, 1938; Eau Gallie, Aug. 8, 9, 1938; Lake Streaty, Aug. 10, 1938; Dug Creek, Aug. 15, 16; large series. Determined by D. G. Hall.

This brownish-yellow fly, a little smaller than a house-fly, is abundant in nearly all the burrows studied. According to Mr. Hall, it is very close to *Pegomya gopheri* Johnson (described from specimens bred from larvae found feeding on excrement in gopher burrows by Hubbard), but he is inclined to believe that a new species is represented. Unfortunately, all the material which we have collected was taken in molasses traps and preserved in alcohol, and better specimens must be obtained before the identity of the species can be established. There can be little doubt that this *Pegomya* is a true obligate inquiline in the burrows, and the fact that most of the other species found in *Geomys* burrows are distinct from related forms occurring in the burrows of *Gopherus* adds to the probability that this fly is not the same as *P. gopheri.* The feeding habits of the larvae are also not certain; Malloch[24] questions whether the larvae of *P. gopheri* are truly coprophagous, despite Hubbard's statement; and Mr. Hall points out in a recent letter that other species of the genus are miners in leaves, stems and bulbs. It may well be, therefore, that the larvae of the species found in the *Geomys* burrows normally live on the food stores of the pocket-gopher.

Pegomya sp.?

Casual?; cophophage or phytophage in larval stages. Newnan's Lake, Dec. 3, 1939 to Jan., 1940, numerous specimens. Determined by T. H. Hubbell.

[24]*Bull. Brooklyn Ent. Soc.,* Vol. 15 (1920), p. 124.

A second species of fly that has been found only in burrows near Newnan's Lake is very similar to the last (with which it occurs) except in its much darker coloration and somewhat different pattern. Its general appearance is dark brown or grayish brown instead of yellowish. The occipital region of the head, the entire thorax, and the legs are rather dark brown, the tarsi being distinctly darker than in the first-mentioned species of *Pegomya;* the dorsum of the abdomen is also distinctly grayer than in the other species, which is almost entirely of a yellowish color with faintly darkened tarsi.

SARCOPHAGIDAE

Sarcophaga sp.

Casual?: parasitic, coprophagous or necrophagous in larval stages. Leesburg, June 11,1938, 1 ♀. Determined by D. G. Hall.

It is impossible to say whether or not this fly is a member of the burrow fauna, since its larval habits are unknown. Some of the sarcophagids parasitize Orthoptera, and *Ceuthophilus latibuli* is attacked by the tachinid *Oedematocera flaveola* Coquillet; possibly the "blind cricket" (*Typhloceuthophilus*) of *Geomys* burrows is similarly parasitized by a *Sarcophaga.* It may be that the larvae of this fly feed upon pocket-gopher feces; or again its occurrence in the burrow may have been fortuitous.

SIPHONAPTERA

**Foxella ignotus* (Baker)

It was surprising that no fleas were found in any of the burrows excavated by Goff. We are informed by Dr. Wm. L. Jellison of the Rocky Mountain Laboratory, U. S. Public Health Service, that some subspecies of *Foxella ignotus* (Baker) is usually found wherever *Geomys* or *Thomomys* occurs.

HYMENOPTERA

FORMICIDAE

A large number of ants were taken in *Geomys* burrows. They cannot be classed as true pholobionts, since it is evident that they have free access to the outer world as well as to the pocket-gopher tunnels. No attempt has been made to evaluate their roles in the burrow biocoenose, but we may safely assume that they abstract much more food, both vegetable and animal, than they bring in. The species taken in the burrows are listed below; all were determined by M. R. Smith.

Ponera opaciceps Mayr

Casual. Leesburg, March 28, 30, April 15, 1938.

Euponera (*Trachymesopus*) *stigma* (Fabricius)

Casual. Leesburg, March 30, April 15, 1938; Lake Streaty, Aug. 8, 1938.

Eciton (*Acamatus*) *carolinensis* Emery

Casual. Leesburg, April 15, 1938.

Eciton (*Acamatus*) *schmitti* Emery

Casual. Leesburg, July 7, 1938; Dug Creek, Aug. 16, 1938.

Monomorium minimum Buckley

Casual. Lake Streaty, Aug. 10, 1938.

Solenopsis molesta Say

Casual. Leesburg, April 15, 1938; Eau Gallie, May 1, 1938.

Solenopsis pergandei Forel

Casual. Leesburg, April 15, 1938.

Solenopsis geminata subsp. *rufa* (Jerdon)

Casual. Leesburg, March 30, April 15, June 11, 1938; Eau Gallie, May 1, 1938; Dug Creek, Aug. 16, 1938.

Pheidole metallescens Emery

Casual. Leesburg, March 28, 30, June 11, July 7, 1938.

Aphaenogaster sp.

Casual. St. Cloud, Aug. 8, 1938.

Trachymyrmex septentrionalis obscurior var. *seminole* Wheeler

Casual. Leesburg, June 11, 1938; Dug Creek, Aug. 16, 1938.

Dorymyrmex pyramicus var. *flavus* MacCook

Casual. Leesburg, March 28, 31, 1938; St. Cloud, Aug. 8, 1938.

Iridomyrmex pruinosus (Roger)

Casual. Lake Streaty, Aug. 10, 1938.

Camponotus socius Roger

Casual. Dug Creek, Aug. 16, 1938.

SPHECIDAE

Larrinae

Larropsis discreta (FOX)?

Casual?; parasitoid in larval stages; adult a grasshopper-hunter. Leesburg, April 15, 1938, 1 specimen. Determined by G. A. Sandhouse.

It is possible that this hunting-wasp preys upon *Ceuthophilus* and *Typhloceuthophilus*, seeking them in holes in the ground. On the other hand its presence in the burrow may have been fortuitous. The species is little known; Miss Sandhouse identified it with some doubt, noting that she had not previously seen the species, and had made the identification from the description alone.

A BRIEF HISTORY OF TOMATO PRODUCTION IN FLORIDA

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Tomato-growing was introduced into the northern portion of Florida soon after the Civil War. In 1870, C. P. Perry and P. F. Wilson were experimenting with small garden patches of tomatoes and other truck crops in the Arredondo section of Alachua County. In 1872, S. J. Crown, Sr., an experienced vegetable grower, came to Florida with a Mr. Burr and located at Palmer. During the first year they grew successfully twenty acres of tomatoes, the first extensive commercial planting in the state. Because of this and other later success the Arredondo region became the first tomato-growing section in Florida.

In April, 1882, Florida tomatoes were quoted[1] on the Chicago market at $4 and $4.50 per bushel crate, and it seems that a great bit of experimenting was done to insure arrival of the fruits at their destination in the best possible condition.

While the Arredondo region was still in its pioneer stage, other sections of Florida were beginning to grow tomatoes. As early as 1872, tomatoes were grown by E. S. Blund on Sanibel Island on the lower Gulf Coast. In 1875, Mr. Gillette grew one acre of tomatoes profitably in the Bradenton section of Manatee County and sent them to New York in boxes and barrels.

The early development of tomato culture in sections of the lower peninsula, which were mainly on the coast of the Gulf of Mexico, was retarded by the lack of transportation facilities. It was necessary to ship by boat from the Sanibel region to Key West and there reload on boats bound for New York or transport them to Cedar Key, where they were forwarded by rail to northern markets. With the extension of railroads into southern Florida, growers began to migrate southward from the Arredondo region. This migration took place because of an earlier growing season, which made it possible to put the tomatoes on the northern market earlier. The result was a decrease in the acreage planted to tomatoes in the Arredondo section and by 1900 it was almost abandoned. At present very little commercial vegetable growing is done in that section.

[1]Anonymous, "Vegetable Markets West and North," *Florida Dispatch*, Vol. 1 (1882), p. 12.

During the decline of the industry in Alachua County, important tomato growing centers became established at Grand Island in Lake County and at Winter Haven in Polk County, and these sections retained first rank for several years. In 1893, Hastings[2] listed the principal tomato-growing counties in Florida as follows: Polk, Manatee, Brevard, Lake, Lee, and Dade. At that time buyers for northern markets rode to centers of production on horseback to purchase the crop.

Tomatoes were first shipped from the Keys in 1889.[3] By 1890 growers were producing tomatoes in small scattered areas on the western Florida Keys from Cape Romano to Cape Sable and on the larger Keys between the Florida mainland and Key West.

A great portion of the Florida Keys is rocky, but a fairly large acreage of tomatoes was grown on land cleared of brush with machetes and the tomato plants were set in the loose humus accumulated in crevices of the rocks. Although the soil in the lower West Coast section was suitable for commercial tomato production, the mosquitoes during the summer made the region uninhabitable.

After 1894, small, scattered tomato-growing districts came into prominence in the central Gulf region, from Fort Myers northward to Tampa. By 1897 there was also a fair sized acreage around De-Funiak Springs on the upper Gulf Coast, and near St. Augustine on the East Coast. In 1896 the following acreage was reported:[4] Manatee 3000, Winter Haven 2500, Clermont 900, Grand Island 600, and Sanibel 100.

South Florida is at present the most important tomato-growing district, although it was the last of the large areas to be started. Its history is as interesting as it is peculiar and distinctive.

There had been a few settlers in Dade County since the time of the Civil War but those pioneers had engaged mainly in the production of sub-tropical fruits, especially citrus fruits, or had lived by fishing and by growing small plots of tomatoes and other truck crops on the pinelands.

It remained for Mr. Robert Douthit, a native of North Carolina, who settled at Lemon City in 1891, to correct the erroneous idea, widely believed by the native inhabitants at that time, that the marl

[2]Hastings, H. G., "A Year's Progress in Gardening," *Florida Dispatch, Farmer and Fruit Grower,* Vol. 5 (1893), p. 292.

[3]Anonymous, "'C. G.' Farming on the Keys," *Florida Dispatch, Farmer and Fruit Grower,* Vol. 2 (1890), p. 390.

[4]Anonymous, "Vegetables and Berries Acreage and Shipments," *Florida Farmer and Fruit Grower,* Vol. 8 (1896), p. 243.

and muck soils of the Everglades and its immediate environs were poisonous to plants and thus unproductive. After watching for two or three years an old negro's garden to which stable manure was applied, Douthit decided that vegetables could be grown on a large scale if compost, the commercial name given to cured stable manure, was applied to the plants. In 1894, he grew a small field to tomatoes successfully by using this material. The next year Douthit went to Key West and bargained for enough compost to grow his crop of four acres. His experiment proved that with the use of compost tomatoes could be successfully grown, and this was the beginning of the tomato industry in Dade County.

Tomato-growing in Dade County was given further impetus by the migration of S. L. Peters[5,6] to that section from Sumter County in 1896. Peters, who had learned, prior to moving to Dade County, the latest methods of harvesting, packing and shipping, joined with Douthit to establish tomato-growing as the main occupation in that part of Dade County.

The first carload of tomatoes was shipped out of Dade County by Peters in 1897. He planted sixty acres of tomatoes each year during 1897 and 1898. He was entirely successful during the first year, but the harvest had scarcely begun in 1898 when a frost killed the entire crop in the northern part of the county. After the freeze, Peters and Douthit made a trip into the southern part of the county, where they found no frost damage and the following year they began farming jointly in the Cutler region, where they planted about 150 acres of tomatoes. At that time the Florida East Coast Railway did not extend south of Miami, so a dock was constructed at Cutler large enough to accommodate coast trade schooners. From there the tomatoes were shipped by water to Miami where they were loaded into railway cars for shipment to northern markets.

During the early years a majority of the farms in the Cutler region were limited to four or five acres principally because of the scarcity of help and the antiquated methods. Each grower had a temporary packing house in the field. Here the tomatoes were packed for market by women of the community and by commercial packers. After the farmer stopped picking in the evening, he hauled the crated tomatoes to the docks at Cutler for shipment and brought back on each trip crates for his next pickings.

[5]Heimberger, Lindley, "But a Case of Luck—A Practical Lesson in Soil Bacteriology," *Florida Grower,* Vol. 17 (1918), pp. 9, 10.

[6]Matlock, Shelton S., "Tomato Industry on the Lower East Coast," *Florida Grower,* Vol. 29 (1924), p. 6.

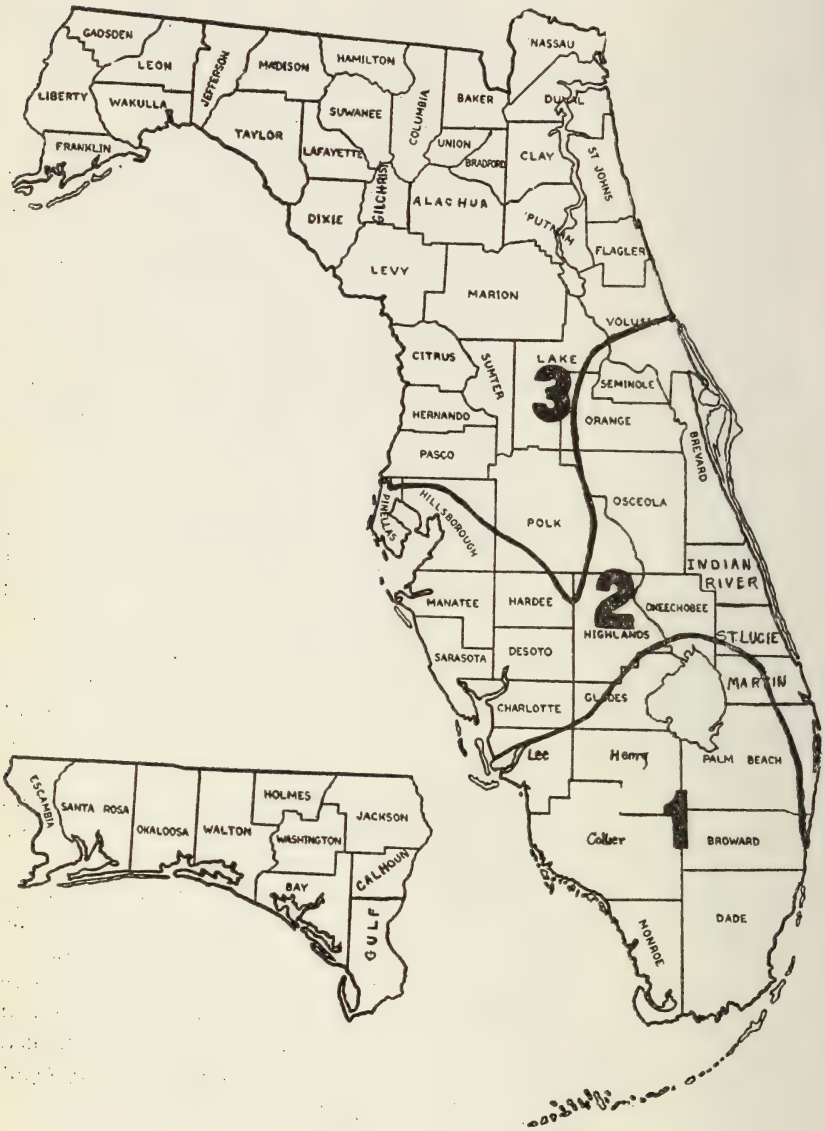

FIG. 1.—The southward trend of the tomato industry can be traced by the counties. The three arbitrarily designated areas are separated by soil type, planting season and predominant tomato diseases found in each.

All early plantings at Cutler were made on the highest glade land available, which was generally the driest land and almost always bordered along the pine-lands. As soon as the water receded following the rainy season of late summer, the plantings were begun and continued until large acreages were set to tomatoes. In this way the fruit matured at different times, thus distributing the harvesting and marketing seasons over most of the winter months. From Cutler tomato-planting gradually spread southward. About forty acres were under cultivation in the Homestead region in 1907, at which date the first carload of tomatoes was shipped from south Dade County.

Further details of this gradual shifting of the center of the tomato-growing industry from the northern to the extreme southern part of the state may be learned from the reports of the State Commissioner of Agriculture from 1889 to 1932. The first report issued in 1889 shows the tomato-producing counties in relation to their importance as follows: Alachua, Lake, Orange, Sumter, Dade, and Polk, with a total of 4340 acres planted. This relative order held until about the year 1895 when the order of rank was Polk, Lake, Marion, Alachua, Orange and Brevard. By 1900, Lee replaced Polk in first place and the next year Dade headed the list of counties and since that time has retained the lead in total acreage. Since 1900, second place has been held successively by Polk, Sumter, Brevard, Palm Beach and Collier with third place occupied by Lee, Palm Beach and Manatee. Thus, the trend for the earliest-planted tomatoes has been from Alachua County, where the Florida tomato-growing industry originated, southward, thence to the two coastal regions and finally settling in the relatively frost-free areas of the south peninsula and Keys for the earliest plantings followed by certain east and west coastal regions as the second-early and the central and northern areas for the remaining plantings (Fig. 1). The total acreage has increased from 4340 acres in 1889 to 6675 in 1900; 16,168 in 1910; 21,186 in 1920; 29,814 in 1930; and 41,300 in 1938.

According to Briggs,[7] Day,[8] and Hooks,[9] the most widely grown varieties in the tomato sections of Florida about 1890 were Acme, Stone, Favorite, Perfection and Beauty. Previous to that time, a great number of varieties were tried and discontinued, principally

[7]Briggs, J. B., "Tomato Notes from Polk County," *Florida Farmer and Fruit Grower,* Vol. 6 (1894), p. 22.

[8]Day, J. W., "Tomato Culture in the South," *Florida Dispatch, Farmer and Fruit Grower,* Vol. 3 (1891), p. 147.

[9]Hooks, R. C., "Growing Tomatoes," *Florida Agriculturist,* Vol. 18 (1891), p. 178.

because of undesirable fruit type and unproductiveness. Rolfs[10] listed twelve good tomatoes for Florida, which included those mentioned above and he stated[11] later that: "It is not out of place to emphasize the advice given before, that one should procure nothing short of the very best article in buying seed." These varieties were gradually replaced by others and between 1920 and 1925, Lord Baltimore, Gulf State Market, Rosy Morn, Globe, and Cooper's Special were the varieties generally planted.

After 1925, the Marglobe rapidly replaced the existing varieties because of its resistance to nailhead spot. At the present time the Marglobe still occupies three-fourths or more of acreage, followed by Grothen Red, Globe, Cooper's Special and several other newer varieties. As early as 1876 Crown was providing tomato seed beds with shades for July and August plantings and with substantial covers for frost prevention during December and January in Alachua County. Powers[12] was advocating this procedure in 1891, and during the last half century the methods have remained practically the same.

Fertilization of the soil was a problem almost from the beginning of the industry. Hooks[13] stated that fertilizer put too close to the plants would burn them and injure the roots. Today we are still continuing experimental work on placement of fertilizer in relation to plants. Day[14] cautioned the growers about using too much ammonia on rich soil because it caused tomatoes to crack and rot at the blossom end, should drought occur. Hastings[15] stated that the best tomato soil was sandy and not rich, to which was added a high potash fertilizer. Inman[16] used the ordinary fertilizers on rich soil

[10]Rolfs, P. H., "The Tomato and Some of its Diseases," *Florida Agricultural Experiment Station Bulletin,* Vol. 21 (1893), pp. 25-38.

[11]———, "Some Market Vegetables for Florida," *Florida Agricultural Experiment Station Bulletin,* Vol. 31 (1895), pp. 188-199.

[12]Powers, Stephen, "Vegetables for Rich People," *Florida Dispatch, Farmer and Fruit Grower,* Vol. 3 (1891), p. 266.

[13]*Loc. cit.*

[14]*Loc. cit.*

[15]*Loc. cit.*

[16]Inman, Fred W., "Some Very Profitable Tomato Growing," *Florida Dispatch, Farmer and Fruit Grower,* Vol. 3 (1891), p. 326.

[17]McQuarrie, C. K., "Tomato Culture," *Florida Agriculturist,* Vol. 24 (1897), pp. 82, 83.

and with good cultivation produced fruit that would bear transportation without softening, withering or rotting. McQuarrie[17] was convinced that if plenty of potash was used along with a reasonable quantity of phosphoric acid, there would be less blight and fungous diseases on the tomato plants, because he contended that succulent plants were more susceptible. Phosphorus is necessary and potash is indispensable in these formulae for the production of fruit that will stand up in transit.

The exact time to pick the green fruit from the plant has long been a question for argument and is still an unsettled point. An early grower[18] in 1888 stated that they must be gathered at the right stage found principally by experience, "a time when they are just ready to show color but do not yet begin to show it." In the beginning of the industry growers undoubtedly picked the tomatoes at a much later stage than they do at the present time. In 1883 Ashmead[19] wrote, and later Day[20] agreed, that tomatoes should not be picked until they show signs of coloring and Hastings[21] advised that tomatoes should be picked for shipment when they show a yellow cast.

The earliest grown tomatoes were packed in slat crates and shipped from Palmer and Arredondo by the Seaboard Railway to northern markets. The packing was done by the whole family, sitting on the floor around piles of tomatoes, wrapping two fruits with the stem-ends together in a single paper and packing them for shipment. Because of the decay in transit, resulting from this method of packing, growers were advised[18,19,22,23] to wrap the fruit singly and to exclude all unsound fruit. Bryson[24] in 1885 advised strongly

[18]Anonymous, "Preparing for Market. Tomatoes," *Florida Dispatch,* Vol. 8 (1888), p. 229.

[19]Ashmead, W. H., "Packing and Shipping," *Florida Dispatch,* Vol. 2 (1883), p. 168.

[20]*Loc. cit.*

[21]*Loc. cit.*

[22]Curtiss, A. M., "The Tomato Crop," *Florida Farmer and Fruit Grower,* Vol. 1 (1887), p. 74.

[23]Powers, Stephen, "Trucking on the Gulf Coast," *Florida Dispatch, Farmer and Fruit Grower,* Vol. 4 (1892), p. 766.

[24]Bryson, George E., "Packing Tomatoes," *Florida Dispatch,* Vol. 4 (1885), p. 436.

against wrapping and packing tomatoes in green moss for shipment because of the excessive amount of spoilage resulting from higher humidity.

Disease of the plants in the fields were apparently on the increase as the industry spread, as is indicated by inquiries made by the growers.[25, 26, 27, 28] Mr. Crown told the writer that the early settlers of Alachua County in 1880 did not have any tomato diseases as they do now. As early as 1893, less than ten years after Millardet had thoroughly tested out his newly discovered formula for bordeaux mixture, Smith[29] stated that it was beneficial if used as a preventive rather than a cure for tomato diseases in Florida. Rolfs[30] first mentioned tomato diseases in 1892 and wrote[31] at length about them in 1898.

[25]Aldrich, A. J., "Tomato Vines Wilting," *Florida Dispatch, Farmer and Fruit Grower,* Vol. 1 (1889), p. 469.

[26]Painter, E. O., "Growing Vegetables on High Pine Land," *Florida Dispatch, Farmer and Fruit Grower,* Vol. 1 (1889), p. 398.

[27]Reagan, J. E., "How Can Tomatoes Be Grown?" *Florida Dispatch, Farmer and Fruit Grower,* Vol. 1 (1889), p. 131.

[28]Williams, V. L., "Dying Tomatoes," *Florida Dispatch,* Vol. 2 (1883), p. 404.

[29]Smith, A. A., "Bordeaux Mixture Prevents Tomato Blight," *Florida Farmer and Fruit Grower,* Vol. 5 (1893), p. 334.

[30]Rolfs, P. H., "Grasses, Forage, Plants, Tomato Blight," *Florida Agricultural Experiment Station Bulletin,* Vol. 18 (1892), p. 10.

31———, "Diseases of the Tomato," *Florida Agricultural Experiment Station Bulletin,* Vol. 47 (1898), pp. 115-152.

A MARINE BIOLOGICAL LABORATORY ON THE GULF COAST OF FLORIDA

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In 1934 and 1935 there was a tremendous mortality of oysters in Apalachicola Bay, which the oystermen attributed to what they called the "leech." This organism is actually a flatworm which is able to enter between the valves of oysters and feed upon the meat. At the request of the Florida oyster industry and state officials the Bureau of Fisheries established a temporary laboratory near Apalachicola Bay and obtained Professor A. S. Pearse, of Duke University, to make an investigation of this particular organism. Dr. Pearse and his assistants made a considerable study of the life history and habits of the "leech" and concluded that it was responsible for at least a large portion of the mortality of the oysters. He concluded, further, that the "leech" is able to thrive only in water of relatively high salinity and disappears when the salinity is lowered to roughly half that of normal sea water.

After these investigations were completed in 1936 the need was felt by the fisheries industries of the Gulf Coast for a permanent laboratory which would be headquarters for scientific studies of oysters and other commercial marine organisms. Unfortunately, the location of the temporary Apalachicola laboratory was not completely satisfactory for such a broad program of investigation.

After considerable study it was decided that better conditions for laboratory work of a broad nature could be obtained in the vicinity of Pensacola where clean, clear water of relatively uniform high salinity obtains through the year. It was soon learned that the Pensacola Quarantine Station was being abandoned by the Public Health Service and was available for transfer immediately. Arrangements were made to transfer this station with its buildings and equipment to the Bureau of Fisheries for conversion into a marine fisheries biological laboratory. The old Quarantine Station was most favorably situated for the purpose of the Bureau of Fisheries for a number of reasons. It is located about eight miles from Pensacola and consists of ten buildings on an artificial island in Santa Rosa Sound. The island, constructed at the end of the last

century, was built of ballast rock from sailing ships. Since the ground is from eight to ten feet above average water lever there is ample protection from storm tides. The island comprises between fourteen and fifteen acres and there is abundant space for construction of additional buildings when necessary.

The largest building was converted into a laboratory. Some of the other buildings are used as residences. In addition, there is a large shed which has been converted into a workshop for construction of apparatus and equipment. There is an excellent boat shed, protected by a rock breakwater.

In 1938 funds were made available by PWA and WPA for the improvement of the grounds, enlargement of the most important buildings, and construction of a road and bridge to the island. Much of this work has now been completed. It is expected that the entire program will be completed in the near future and that facilities for other types of biological work will be available.

The laboratory building contains an office and five private research rooms as follows: a large general research room, with table accommodations for nine investigators; a chemical research room; a photographic and experimental dark-room; and, upstairs, a library room, approximately thirty by thirty feet and a room which it is intended to use as a museum of marine organisms, approximately thirty by sixty feet. The laboratory research facilities include running sea water and fresh water, gas and electricity. The library, which at present contains only a few hundred volumes devoted primarily to marine biology and related fields, is being rapidly expanded.

The laboratory is equipped with an adequate supply of glassware and aquarium tanks for ordinary biological work. Additional equipment such as a microtome, kymographs, and similar instruments, is also on hand. A supply of the more commonly used biological stains and chemicals is maintained.

Under construction on the grounds are the outdoor experimental tanks. These are made of concrete and will be provided with running salt water. Two of the tanks are fifteen by thirty feet, and two are ten by twenty feet; all are five feet deep. These are intended for use in investigations on relatively large organisms which may be maintained under continuous observation and approximately natural conditions.

Dallin Aerial Surveys, Phila.

U. S. FISHERIES BIOLOGICAL LABORATORIES, PENSACOLA

The station has enough boats to provide for the needs of a limited number of investigators and it is expected that in the near future further floating equipment will be available. There are now three skiffs with outboard motors, a thirty-eight-foot cabin launch and a nineteen-foot speed-boat. With these boats it is readily possible to reach, within a very short time, almost any type of marine environment which the region affords.

For the accommodation of visiting investigators the former hospital building of the Quarantine Station has been altered and enlarged to provide quarters for about twelve individuals; there are also a kitchen and a dining room here and meals will be served if this seems desirable. The station is not operated simply as a summer laboratory, but is in use the year around. One need not live at the station when carrying on research, but may commute the short distance from Pensacola.

There are several advantages of the Pensacola location for carrying on marine investigations on the Gulf Coast. It is relatively centrally located and almost entirely free of the long periods of depressed salinity which might be found during flood time nearer the mouth of the Mississippi River. The sea water is almost always very clear. Only rarely do the small rivers of the region empty enough muddy water into Pensacola Bay to disturb this portion of Santa Rosa Sound. The salinity of the water at this place usually varies during the year between twenty and thirty p.p. 1000 as compared to thirty-five to thirty-six p.p. 1000 for pure sea water. The Pensacola region is most favorable in being the site of large fisheries of red snapper, grouper, mullet, sea-trout, shrimp, oysters, etc. There is still much work to be done on these organisms. In fact, there has been little systematic work done on the marine organisms, both invertebrate and vertebrate, of the Gulf Coast as a whole and this laboratory is so centrally located as to offer unexcelled advantages for such studies. Within a few miles of the laboratory one may find extensive sand and mud flats, shell bottoms, rocky shores, brackish estuaries, and a few miles off shore, coral reefs. The laboratory is somewhat less than a mile from the Gulf beach although the island, itself, is located in Santa Rosa Sound.

It is our purpose to make this laboratory the headquarters for marine biological investigations on the Gulf Coast. The station is intended, naturally, primarily for the use of biologists studying problems related to fisheries, and precedence will be given to visiting investigators interested in such problems. However, it is to be emphasized that we realize well that ecological and physiological factors affecting commercial organisms may frequently be most effectively studied in an indirect manner, and that scientific information so developed may eventually be of great advantage to fisheries science. It is intended to make the facilities and accommodations of the station available to those biologists who wish to use them for carrying on significant marine investigations and it is hoped that biologists will take advantage of the facilities of the new Pensacola Laboratory.

BIOLOGICAL EFFECTS OF RADIATIONS OF DIFFERENT WAVE-LENGTHS

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The question concerning the specific effects of wave-lengths of radiations on biological materials is of fairly recent origin. The first known attempt was made by Wood.[1] He exposed mouse tumor tissues to X-rays of wave-lengths ranging from 0.21 to 0.71 Ångstroms. He found that the lethal dose for the tumor tissues depended on the energy absorbed and not at all on the wave-lengths of the radiations. Similar experiments were made by the author[2] in 1935-36 on seeds using wave-lengths from 0.12 to 0.6 Ångstroms. These experiments showed that the injurious as well as the beneficial effects were dependent primarily on the energy absorbed and not on the quality of the radiation. On the other hand, in an effort to try new remedies on patients, some physicians reported astonishingly good results in the cure of cancer with X-rays produced by 800,000 volts and more.

From the physical point of view the biological effects of X-rays should depend entirely on the absorbed energy. The biological effects are no doubt due to the altered chemical composition of the biological materials. The altered chemical composition is doubtless due to some physical forces which create changes in valence with consequent changes in molecular composition. So far as is known, the effect of the short-wave radiations is primarily to produce the ejection of photoelectrons from the atoms of the tissues. The tissues of humans, consisting as they do primarily of carbohydrates, have photoelectric threshold wave-lengths which are very much longer than any of the X-ray wave lengths used. From this point of view, the effects of X-rays should depend entirely on the energy absorbed and should be independent of the wave-length of the radiation used.

The greater effectiveness of short-wave X-rays in treating cancer seems to contradict these views. However, a closer examination of the physical conditions explains the reason for this contradiction.

[1]Wood, F. C., "The Effect on Tumors of Radiation of Different Wave-lengths," *American Journal Roentgenology*, Vol. 12 (1924) pp. 474-481.

[2]Bless, A. A., *Proceedings of the National Academy of Science*, Vol. 23 (1937), pp. 194-196.

When X-rays encounter a substance, a part of the rays is scattered and another part is absorbed. The fraction of the beam scattered is essentially independent of the wave-length, while the fraction absorbed is directly proportional to the cube of the wave-length. For X-rays of wave-length 0.7 Ångstroms, the ratio of the scattered fraction to the fraction absorbed is only 0.27, while for a wave-length of 0.13 Ångstroms the ratio is 32. For 800,000 volt X-rays the ratio is about 30,000. It is evident, therefore, that the fraction of long-wave radiations absorbed is vastly greater than the fraction scattered, while the reverse holds true for short-wave X-rays.

Because of the fact that the absorption of a given material varies as the cube of the wave-length of X-rays incident upon the material, the fraction absorbed from the original beam of 800,000 volt X-rays is .001 of the fraction absorbed from X-rays produced by 80,000 volts.

When X-rays of long wave-length are incident on the human body, a very large portion of the rays is absorbed by the surface tissues. In order to have a beam of a given intensity reach the interior of the human body, the dose of X-rays must be extremely heavy. But in such a case, the fraction absorbed by surface tissues would be high enough to cause grave injuries. In order to reduce surface absorption, it is necessary to use X-rays of very short wave-length. However, in this case, the fraction of the original beam absorbed by the interior tissues is also extremely small and, in general, insufficient to accomplish anything useful. The key to the problem lies in the scattered rays.

As is well known, X-rays undergo an increase in wave-length on scattering. As stated previously, the fraction of 800,000 volt X-rays scattered is about 30,000 times as large as that absorbed. When deep seated cancer is treated, the beam of X-rays in its passage through the human tissues is scattered a large number of times with the consequent decrease in hardness. Because of the increase in the wave-length after a few scatterings, the rays become soft enough to be absorbed by the diseased tissues. It is evident, then, that the biological effects may be explained here also on the basis of absorbed energy.

Very recently Meier,[3] working on the effects of ultraviolet radiations on algae, found that for the same intensity the lethal effects of rays of a certain wave-length were very much greater than of other

[3]Meier, Florence E., "Lethal Effect of Short Wave-length of the Ultraviolet on the Alga Chorella Vulgaris," *Smithsonian Miscellaneous Collection,* Vol. 95 (1924), pp. 1-19.

wave-lengths. It is extremely difficult to account for this selective action. It has been suggested that some of the molecules of the algae may have absorption bands near the critical wave lengths. Molecules subjected to the influence of radiation of the proper wave-length may suffer dissociation with lethal effects to the whole organism. More experiments are needed before a satisfactory explanation of this effect is found.

THE SCIENTIFIC STATUS OF FISH CULTURE AND LAKE MANAGEMENT IN FLORIDA

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The State of Florida is indeed fortunate in that it has a priceless heritage in the form of beautiful lakes scattered extensively over the whole of its surface. The climate is ideal for the rapid growth of the fauna of the lakes and for the reaping of the rich harvest throughout the year. These are its priceless possessions which attract people from other states who wish to relax and enjoy a sport in which everyone may take part without having to stand on the sidelines and watch. This is a heritage which other states have already lost and are attempting to regain, and of which Florida is just becoming aware.

Lately the average citizen of the state has become conscious of the fact that the fishing resources are priceless and that they have been seriously wasted. He is frantically demanding fish and more fish to replace those already removed from the lakes, little realizing that the rehabilitation is not so simple and that in many cases to attempt it is entirely futile. Little has been done to educate him and no facts have been brought before the public on this question. I am placing before you some of the problems which it remains for the scientist to solve before much can be done to bring these bodies of water back to anything like their natural state.

Some states are making headway along these lines. Michigan has its Fisheries Institute connected with the University, and partially supported by the State Conservation Department and the United States Bureau of Fisheries. Cornell has its School of Fisheries, as does Washington State. Ohio has its Scientific Division in the Conservation Unit intimately connected with the University proper. Minnesota has a professor of aquatic ecology who is partially supported by the Conservation Department. Which of these states has greater use of such a department than Florida?

Let us discuss the problems involved in the production of fish. For the last seven years I have been working on the ecology of the bass pond with respect to the fertilization of these ponds and to the increasing of their productivity. Only this year the results of the labor bore fruit.

Fish may be fed on three levels. They may be left in ponds to live on natural foods. Secondly, forage fish may be included and probably should increase the amount of fish produced on a unit area. Lastly, the fish may be fed by hand, and theoretically, the amount of fish flesh produced in this way is only limited by space.

Let us look at the first level and merely outline some of the problems. Bass are cannibalistic; how can they be produced in large numbers without their living off of one another? The complete ecology of the pond with bass alone needs to be worked out. How does the association start? Of what is it composed? What factors control cannibalism? Does vegetation, shape of the pond, or turbidity of the water have any effect?

In fertilizing ponds what is the food chain or chains that lead from fertilizer to bass? What is the relationship between chemical compounds, plankton, and bottom organisms? What bacteria occur in the pond? What is their role? What fertilizers will expedite the growth of fish and increase the number of pounds of flesh produced? Is there a relationship between the various forms of food in the pond and fish production? Does this vary with the species?

Some of these I have been able to answer in a rough way working by myself over a period of time, but many have not been answered. The ecology of the production of bass by themselves in the pond has been partially covered, but there are many perplexing problems regarding the use of forage fish that must be settled. Let us glance at these problems.

After these problems on fertilization have been answered, we may include forage food in the pond. This problem has not been touched. I have made a few preliminary experiments to help determine which way to direct the studies, but no satisfactory solution has been found. Scattered studies have been made of the life histories of a number of forage fish, although little has been done to connect them with bass.

The life history of at least a half dozen important forage fish in this section needs to be worked out. What are their food habits? How do they spawn, and at what time of the year? How many young are produced per individual, and how fast do they grow? The ecology of the pond needs to be worked out with reference only to the forage fishes in fertilized ponds with natural acquatic foods. They may then be tried in promising combinations; later they may be combined with bass to see what effect they might have on production. Nothing is known of most of these fishes to begin with.

In the third phase of the problem we know that only about ten percent of the largemouth bass will feed from the hand by training. Various methods have been tried and carried over from the production of smallmouth, but the two species are very different in their habits, so the method is not successful for both. So much for the production side of the field.

In the management of waters we have come to the conclusion, from observations, that a lake is like a piece of farm land. It can be cultivated and it has different degrees of fertility according to the drainage from surrounding territory. The major problem in Florida at the present time seems to me to be the conservation of the soil organic matter by preventing indiscriminate burning. As we make white deserts of our farm lands we are also making deserts of our lakes, for they receive their fertility by drainage from the surrounding land.

In stocking the lake several questions immediately present themselves. How many fish shall we plant per unit area? How large should these fish be to get the maximum results, both from the economy of rearing them at the hatchery and the economy of survival in the lake? We do not know. How many fish can be supported on an acre of water, and how many pounds of fish may be cropped off of this area? We do not know. We still have these problems facing us, yet we continue to dump fish into the lakes of the state without any apparent results.

Of what does the fertility of the lake consist? How are the bottom deposits involved? Do they effect the production of certain kinds of food? If so how can the digestion of these deposits be brought about so that they may contribute to the food cycle in the lake and not accumulate as peat and coal? What organic compounds are present? Are they related in some way to plankton? Does plankton, in turn, have any relationship to fish production?

We need to study the feeding and spawning habits of the various associations of fishes to determine what part each plays in the economy of the lake. How are they included in the food chain? What is the relationship of the various aquatic organisms and their life cycles to fish production? What are the remedial measures other than stocking that might be applied to the body of water, or is stocking necessary in the first place?

In what way can lakes which are less productive be improved? Can we use artifical devices to afford protection to the young fish or spawning places for forage minnows, or habitats for other aquatic

organisms? Can we promote improvements by planting certain types of vegetation? Will fertilization help? What is the ideal toward which we are working?

One can see from this short resume that the problems are practically limitless. They may be theoretical or may deal with one minute phase such as the life history of one organism, or they may be as practical as the most ardent business man could desire. Each serves its purpose.

Problems which years ago were purely scientific are now the basis upon which our investigations have started or by which they are directed today. The production of fish, including the problem of diseases, and the management of lakes is becoming as scientific as agricultural production and is directed along the same lines.

At Welaka we have one of the larger hatcheries of the country. There is an experimental laboratory and nearby the State University maintains quarters and a laboratory for biology students. In the Ocala National Forest the lakes can be opened and closed at will and we have started the study of some of the management problems there. In this state we have the ideal situation in which to work. The climate is such that one can work out of doors the year around. Lakes are abundant, and the governmental agencies will cooperate in every way to expedite the work, for the problem of the conservation of our fishing resources will be solved only by the scientific management of Florida fishing waters.

THE EFFECTS OF IMMERSION ON THE HEMOGRAMS OF SWIMMERS

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The average diurnal variation in the leukocytes and erythrocytes of human blood is restricted to fairly narrow limits. Very few conditions of normal living and activity influence this fixed mean, such as the eating of sizeable meals or violent exercise, and not even then is the variation changed much from average limits. In adults the normal number of white cells per cubic millimeter of whole blood is about 8,000, while the smaller red cells are much more numerous and ordinarily total five million for the same volume.

The differential blood count comprehends the classification of the various kinds of leucocytes in the peripheral blood stream. These, briefly, are the polymorphonuclear neutrophiles or active phagocytic cells, the lymphocytes, the eosinophilic leucocytes, the monocytic leucocytes and certain rarer types.

The relationships between these blood elements, in relative numerical frequency under the influence of things happening in the body, forms a very important diagnostic criterion for the evolution of disease processes. For the increase in the total number of white blood corpuscles (absolute increase) is ordinarily accompanied by increase in the ratio of one type of leucocyte over another (relative increase), and this increase may be in the polymorphonuclear cells (as it often is in acute infections such as appendicitis). And in addition, these polymorphonuclear leucocytes may be so rapidly formed in the bone morrow, as the demand for phagocytosis indicates that mature forms are fewer (delayed maturation) and younger forms, identified by their nucleae and staining qualities, appear in relatively larger numbers.

With these criteria in mind it is interesting to study the effects of immersion upon the total and differential leucocyte counts. Cold water has a high capacity for absorbing heat from the body. As compared to the heat absorbing capacity of air the ratio is 27 to 1, that is, water absorbs body heat twenty-seven times faster than does air. Humans do not possess a compensating mechanism for offsetting this heat loss, as do mammalian aquatic animals, and there-

fore exposure to such cold media may lower body temperatures alarmingly. This is more pronounced in the inactive bather than in the case of the exercising swimmer, but in either case there is definite dissipation of body heat and consequent lowering of various immunity barriers. In practical medical terms this condition may permit the normally present bacterial flora of the nasal and paranasal mucous membranes to flourish at the expense of the host, with production of infection.

Aside from the standpoint of health, the normally reacting mechanism of the tissue and blood cells to cold immersion is interesting. In the natural effort to offset the inroads of infecting organisms, these factors are regularly increased.

In a series of experiments upon laboratory animals and human swimmers the results shown in Tables 1, 2, and 3 were obtained.

TABLE 1

CHANGES IN THE HEMOGRAM OF GUINEA PIGS AFTER CHILLING

	BEFORE	AFTER*	
		1st Test	2nd Test
First Animal:			
White blood cells	8,250	6,850	6,750
Polymorphonuclears	78%	40%	67%
Lymphocytes	19%	60%	32%
Monocytes	3%	.....	.....
Eosinophiles	.....	.....	1%
Basophiles	.....	.....	.....
Second Animal:			
White blood cells	9,850	7,400	7,250
Polymorphonuclears	82%	77%	49%
Lymphocytes	18%	23%	51%
Monocytes	.....	.....	.....
Eosinophiles	.....	.....	.....
Basophiles	.....	.....	.....
Third Animal:			
White blood cells	8,900	6,500	4,400
Polymorphonuclears	63%	39%	44%
Lymphocytes	30%	57%	53%
Monocytes	1%	1%	.....
Eosinophiles	5%	3%	3%
Basophiles	1%	.....	.....

*Time elapsing between exposure and tests about one-half hour.

TABLE 2

EFFECT ON BLOOD CELL COUNT IN MARATHON LIFEGUARDS' RACE, JACKSONVILLE BEACH

NAME	BEFORE						AFTER					
	White Blood Cells	%					White Blood Cells	%				
		Polymorphonuclears	Lymphocytes	Monocytes	Basophiles	Eosinophiles		Polymorphonuclears	Lymphocytes	Monocytes	Basophiles	Eosinophiles
Deloach	7,450	69	31	0	0	0	18,200	94	5	1	0	0
Perkins	5,700	63	34	1	0	2	19,900	93	7	0	0	0
Horton	6,700	80	20	0	0	0	21,750	98	2	0	0	0
Penn	11,000	74	26	0	0	0	33,750	85	15	0	0	0
Miller	8,560	70	30	0	0	0	17,200	88	12	0	0	0
Crenshaw	5,650	72	28	0	0	0	30,400	93	6	0	0	1
Clark	6,700	67	33	0	0	0	18,900	86	12	0	0	2
Liddell	8,600	64	35	1	0	0	12,250	80	20	0	0	0

TABLE 3

EFFECTS OF CHILLING WITHOUT CONCOMITANT EXERCISE

NAME	TEMPERATURE*		PULSE RATE		BLOOD PRESSURE		TOTAL LEUKOCYTE COUNT	
	Before	After	Before	After	Before	After	Before	After
Pittman	98.3	95.4	80	68	126/80	128/90	8,500	8,400
Fortson	98.3	97.0	70	72	118/90	120/88	9,250	8,150
Horton	98.3	97.0	70	60	120/80	130/80	7,100	6,300

*Temperatures were taken by rectum.

SUMMARY AND CONCLUSIONS

Table 1 illustrates the changes in the hemogram of healthy guinea pigs that were tested before and after chilling. Table 3 shows similar changes in non-exercising bathers. Table 2 shows the marked differences occurring in the blood pictures of marathon swimmers before and after a race.

THE SHARK FISHING INDUSTRY OF FLORIDA

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"Oil in Florida"—This magic phrase may not pack the glamour of the blow-off when a new well is brought in, but it does signify the establishment of one of Florida's newest and most flourishing industries—the shark fishing industry.

At the Nutrition Laboratory of the Florida Agricultural Experiment Station we are conducting experiments with shark liver oil and other shark products. My work with these products has revealed some very interesting information concerning this new industry.

Commercial shark fishing is an old industry in Florida. For over 30 years sharks were caught for their hides and fins by the Ocean Leather Company of Newark, N. J. Shark skin is made into highly prized leather which is used in shoe manufacturing mostly as tips for children's shoes, because of its strength and durability. The remainder is made into fine luggage, pocketbooks, belts, and other commodities. The fins are used to make shark fin soup which is considered a rare delicacy by the Chinese.

In 1935, Robert M. French, a graduate chemist residing in Hollywood, Florida, and several of his associates became interested in the oil from the liver of the shark for its vitamin content. From government reports the oil was found to have a variety of uses. In oriental countries shark liver oil is used as the principal fat constituent of the diet and also for illumination. It is used in the manufacture of soap, tanning of hides and skins of domestic animals, in the tempering of steel, and in place of linseed oil as a body material in paints and other related products.

After some research the processing of shark liver oil for its vitamin content was started by Shark Industries, Inc., at Hollywood, Florida. Shark liver oil was found to contain vitamins A and D as in the more familiar cod liver oil.

In 1937, the Florida Agricultural Experiment Station through the efforts of Dr. H. Harold Hume, then Assistant Director of Research, lent a helping hand to this baby industry. The oil was found to be a very potent source of vitamin A, the growth promoting and anti-infective vitamin. At the Nutrition Laboratory we assayed several oils from different species of shark and found from 4,000 to

over 15,000 U. S. P. XI units of vitamin A per gram. In comparison, ordinary cod liver oil averages up to only 1,000 units per gram. Shark liver oil is probably one of the most potent natural sources of vitamin A and is rapidly finding a prominent place in the nutrition of animals and man.

To give you an idea of the growth of this industry, just four years ago there were very few commercial shark fishermen in Florida, and in the Orient for that matter. The annual income to the state was about $5,000. Today, there are 11 shark fishing stations in Florida ranging in location from Fernandina down the east coast to Key West and up the west coast to Cortez. There is over $50,000 invested in boats and fishing equipment. The annual income which comes from other states is around $150,000.

Sharks are found off the entire coast of Florida, around Cuba and the Bahamas, and in the Gulf. Last year about 10,000 sharks were caught in Florida waters and 8,000 gallons of shark liver oil were processed. This year it is predicted from the present catch that more than 40,000 sharks will be caught and about 25,000 gallons of oil will be processed.

In spite of this production there are still very few commercial shark fishermen in Florida because commercial shark fishing is a dangerous business.

To learn more about this new industry, I had the opportunity to go out with the shark fishermen of Salerno Beach.

Two men handle a boat about 24 feet long and 15 feet wide. The boat leaves the dock about 5:30 A. M. with shark bait which consists of bloody fish, usually jack, albercore or stingray, and goes out in the ocean about 3 miles.

Sharks are caught on giant hooks which are spaced at intervals of 25 feet on chains 1,500 feet long. These hooks, which are imported from Sweden are 2½ to 3½ inches long from the point to the shank, and are ¼ of an inch thick. After baiting each hook, the chain is anchored to the bottom at both ends and buoys attached to each end are used to locate the chain. The hooks are worked every 24 hours and pulling in those chains is hard and tedious work. It takes a real man to do battle with these monsters of the deep, especially when the sea is rough. The chain is pulled in at the front of the boat and moved to the rear on rollers while the hooks move along the side of the boat in the water. The shark is pulled up the side and into the boat by means of a winch. Most of the sharks are still alive when pulled up and so a blow on the head between the eyes is necessary to stun them. It is difficult to strike a 700

pound shark in the proper place while it is fighting mad. After the fish is hoisted into the boat, the hook is rebaited and put into the water again.

These imported hooks from Sweden, having a tensile strength of 1,800 pounds, are the best yet found for shark fishing. Nevertheless, on the day I was out, some of the hooks were straightened out, as usual, according to the fishermen. One of the hooks had a shark head about 2 feet long, the remainder of the body having been bitten off at the gills. The fishermen say that there are some big voracious fellows in Florida waters. Often a giant shark will be caught on a hook and as it is being pulled up, there is a sudden jerk, the hook straightens out and the boat is nearly capsized. Recently, one of those big sharks "jerked," broke the mast holding the winch and swam away dragging it and 1,500 feet of chain with him. It is estimated that these big sharks are as long and as wide as the boat. The largest shark caught by Mr. French was 22 feet long and weighed over 1,000 pounds. The liver weighed 240 pounds and yielded 21 gallons of oil; in the stomach were found a few shark heads and other fish, a large bone of a T-bone steak, and a loggerhead turtle, the shell partly decomposed by the strong acid in the stomach; this shark also carried 18 shark pups 1½ to 2 feet long (sharks are live-bearing).

The fishermen told me that sharks do not attack bathers unless they are hungry, and a hungry shark will attack and eat its own grandmother if she is in the vicinity.

When the sharks are brought to the wharf, the fins are removed and placed in the sun for drying. The shark is skinned and the hide is salted. The liver is removed then and the oil is extracted. Sometimes the head is saved and the jaws and the teeth pickled and later sold as souvenirs or curios. Recently, an order for 40,000 man-eating shark teeth was received from Chicago. A national breakfast food company was giving a man-eating shark tooth with a ring through it, to wear on your watch chain in return for their box carton tops. After the removal of the fins, hide, jaws and liver, the rest of the shark is thrown overboard, which means that today 60 to 70% of the shark is being wasted. The Experiment Station is trying to find a use for some of the other by-products of the shark leather-oil-fin industry. The flesh which consists of several hundred pounds to the shark is high in protein content. Analyses indicate over 60% protein on a dry basis. This could be made into fertilizer or can be developed into shark fish meal, which should be valuable as a protein concentrate for use in rations for poultry, swine and cattle.

The liver residue known as liver gurrie, which is left after the oil is removed, also is being discarded. We have found this by-product to be a good source of protein and minerals. It should also contain vitamin G, hepatoflavin, and an anti-anemic factor.

Then there are the glandular products which are useful as pharmaceuticals. Insulin, which is used to control diabetes melletus, has been obtained from the pancreas or sweetbreads; thyroxin from the thyroid gland, and epinephrine, from the adrenal glands. There is hardly any part of the shark which cannot be made into something useful and valuable.

Experiments to determine the value of shark liver oil as a source of vitamin A for poultry are being conducted in the poultry laboratory of the Florida Experiment Station. Some excellent results are being obtained with this oil when compared with cod liver oil. We have found that the poultry grade of shark oil was approximately three times as potent for growing birds as U. S. P. XI cod liver oil, which contains 3,000 units per gram. Experiments have been started to determine the value of shark liver oil in the nutrition of dogs, pigs and cattle.

Shark liver oil is now on the market for human use in the form of capsules. Each capsule contains at least 7,500 U. S. P. XI units of vitamin A. Physicians in Miami have claimed that the oil is beneficial in colds, respiratory inflammations and sinus troubles.

Thus the shark, a pest and a menace to Florida fishermen and sport lovers, the scourge of Florida waters, is being transformed into one of the most valuable creatures of the sea. It is the raw material for a diversity of industries, a new source of health and wealth to Florida.

A PRELIMINARY NOTE ON THE VITAMIN A CONTENT OF THE LIVER OIL OF THE FLORIDA LEMON SHARK (HYPOPRION BREVIROSTRIS POEY)

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No assay of the vitamin A content of oils from the livers of sharks caught in Florida waters has been found in the literature although other investigators have reported the vitamin A content of shark liver oils from different localities and climates.

Schmidt-Nielsen[1] tested the vitamin A content of a number of shark liver oils. The values for the black spiny shark (*Etmopterus spinax*) were 60 to 300 units per gram of oil, the herring shark (*Lamno cornubica*) from 500 to 10,000 units, the ice or Greenland shark (*Somniosus microcephalus*) 2,500 units per gram, and the sun or giant shark (*Cetorhinus maximum* Gunnerus) 10,000 U. S. P. units per gram.

Asenjo, Dalman, and Axtmayer[2] assayed the liver oils from two female sharks (*Carcharinus* sp.) caught in the month of July, 1932, off the coast of Puerto Rico, and reported a vitamin A potency of slightly more than 13,300 Sherman units of vitamin A per gram. This is the first report of the vitamin A content of liver oils from sharks caught in tropical waters.

Jones and Christiansen[3] estimated colorimetrically the vitamin A content of commercial samples of several species of shark liver oil, (nurse, sawfish, leopard, dusky, and sun) to range from 168 to 6,000 U. S. P. X units per gram. Sawfish and leopard shark liver oils rendered from fresh livers, using careful anerobic technique, showed 3,400 and 3,080 U. S. P. X units of vitamin A by colorimetric assay, and 2,222 and 2,700 U. S. P. X units of vitamin A per gram by biological assay.

[1]Schmidt-Nielsen, S. and S., "Der Gehalt Der Knorpelfische an Antirachitischen Vitamin," *Zeitschrift fur Physiologische Chemie,* Vol. 189 (1930), pp. 229-238.

[2]Asenjo, C. F., Dalman, L. M., and Axtmayer, J. H., "The Vitamin A Content of West Indian Shark Liver Oil (*Carcharinus* sp.)," *Puerto Rico Journal of Public Health and Tropical Medicine,* Vol. 11 (1935), pp. 158-162.

[3]Jones, W. S. and Christiansen, W. G., "Shark Liver Oil," *Journal American Pharmaceutical Association,* Vol. 24 (1935), pp. 295-296.

Pugsley[4] has reported the vitamin A potency of the liver oil of the British Columbia "mud" shark (*Hexanchus* griseus) caught in the Portland Canal district to be 8,600 I. U. of vitamin A per gram when determined by a vitameter. (E—1% in 1cm. cell was 5.40).

Morgan, Kimmel and Davison[5] have recently reported commercial shark liver oil from sharks caught on the Pacific coast to contain 12,000 U. S. P. units of vitamin A per gram.

The oil[6] used in this assay was a sample from a mixture of that obtained from approximately a dozen lemon sharks (*Hypoprion brevirostris* Poey)[7] caught off the Atlantic coast of Florida, east of Salerno Beach, in the month of January, 1938.

The livers from these sharks ranged in weight from 13 to 37 pounds, averaging 20 pounds. About four gallons of a dark arber colored oil were rendered from the livers by cooking with live steam for approximately three hours. The sp. gr. was 0.9118.

Using the U. S. P. XI technique,[8] this sample was found to contain over 15,000 U. S. P. XI units of vitamin A per gram.

[4]Pugsley, L. I., "The Vitamin A and D. Potency of a British Columbia Shark Liver Oil," *Progress Reports of Pacific Biological Station, Nanaima, B. C. and Pacafic Fisheries Experiment Station, Prince Rupert, B. C.*, No. 35 (1938), pp. 12-13.

[5]Morgan, A. F., Kimmel, L. and Davison, H. G., "Vitamin Content of Certain Pacific Fish Oils," *Food Research,* Vol. 4 (1939), pp. 145-158.

[6]The oil sample was furnished through the courtesy of Shark Industries, Inc., Hollywood, Florida.

[7]Identified by Springer, S., Zoological Research Supply, Englewood, Florida. (Personal Communication).

[8]*Pharmacopoeia of the United States of America.* First supplement, eleventh decennial revision (1937), pp. 75-82. Prepared by the committee of revision and published by the board of trustees. Agent, Mack Printing Company, Easton, Pa.

THE REACTION OF MAGNOLIA, SCRUB LIVE-OAK, SLASH-PINE, PALMETTO AND OTHER PLANTS TO DUNE ACTIVITY ON THE WESTERN FLORIDA COAST

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INTRODUCTION

To one who has experienced the shade and moist air of an inland magnolia forest; to one who has measured the three or four foot trunks of its large trees, the dwarfed sun-scorched and sea-wind-blasted forms of *Magnolia grandiflora*[1] sprawling over coastal dunes offer striking examples of contrast. Along the coastal highway from Panama City to Pensacola the white sand is often relieved by glistening green magnolia growth, appearing now as a crest to a small sand hill, or again as low compact patches spreading to the width of a house. To be sure, there are also expansive and impenetrable masses of scrub live-oak, of bristly, dwarfed slash-pine, and of waving sea oats; but the magnolias stand out in a singular gloss and green. Large flowers of waxy white are not uncommon on stunted growth scarcely more than waist high. Magnolias in such a strange and hard environment at once raise questions of establishment, growth, and survival. Some of these magnolia masses with their many, crowded, and stubby stems springing from the sand are perched on dunes twenty feet high or more.

How did plants whose seeds ordinarily germinate only in moist, rich soil of shady forests ever become founded on a hot barren sand? The pioneer work done by Cowles[2] in 1899 and later by Fuller[3] in 1934 gave the lead to some of the answers presented. Forty years ago Cowles showed how dunes in their forward march literally bury

[1]Small, J. K., "Scientific Nomenclature," *Manual of the Southeastern Flora.* (New York; Author, 1933).

[2]Cowles, H. C., "The Ecological Relations of the Vegetation on the Sand Dunes of Lake Michigan," *Botanical Gazette,* Vol. 27 (1899), pp. 95-116.

[3]Fuller, G. D., "The Plant Communities of the Dunes," *Scientific Monthly,* Vol. 38 (1934), pp. 444-451.

the very trees that make the development of the dunes possible, and how trees and shrubs meet the problem of survival in smothering sand. With these former works in mind I concentrated my attack on the dunes at Long Beach about eleven miles west of Panama City, Florida. Here there is a dune complex that presents a varied but story-telling pictures: there are dunes of all stages and ages; some are in the process of building; others are in the process of destruction; for some that are advancing and burying vegetation, others are disappearing and exposing partly, if not wholly, dead trees. In some places embryonic dunes give habitat to species which in turn arrest the moving sand and thus make a larger hill possible, while in other localities tearing winds disintegrate long established dunes and lay bare a literal cemetery of perished trees.

OBSERVATIONS

Magnolias in the Active Dunes.—In this complexity of building and destruction I saw the advance of sand in the act of burying firm and free magnolia trees. These trees once normal in form began their existence in the damp soil and shade of vegetation on the margin of a lagoon, or pond, or in a moist depression. Grain by grain, as it were, the sand piles up. First, the single trunk below is buried; next, the primary limbs farther up; and finally, the smaller branches. With only the top above the sand and the base buried below, what was once a tree becomes a wide expansive shrub.

As vertical accumulation of sand continues the shrubby magnolia may keep pace in upward growth but may make no gain above the rising surface of the dune. However, if the substratum permits the shrub may add considerable growth in lateral dimensions; and thus a magnolia tree is lifted aloft to become, in appearance at least, a shrub capping a dune twenty feet or more above the original establishment of the tree.

This choking presents the problem of water or of air intake for roots or stems covered by many feet of sand. Water is abundant enough a few inches down even in these sands parched on the surface. However, stems of trees water-proofed with bark cannot absorb water; and in many species roots deep down where they are deprived of oxygen perish by suffocation. In order to find how magnolias solve the problem of absorption I gave my attention to a number of trees whose once covered trunks, branches, and roots were now laid bare and threatened by the same forces which formerly covered their tops. The exposed dead or partly dead trees (or shrubs) revealed the same unilateral assymetry one notices in

many trees and shrubs of seaside dunes. The windward sides were marked by dwarfing, mutilation, or absence of branches, whereas the leeward side exhibited branch arising from branch always away from the sea and progressively upward like steps of a stairway. In addition, it was noted that as the sand was undermined by the wind the trees necessarily sprawled and leaned leeward against the shifting and diminishing sand mounds.

In some cases it appeared that the original roots deeper down were still functioning. In other instances enormously long adventitious roots issued from the stems higher up. As a matter of fact, it was apparent that, as the stem system reaches upward, new and additional roots appear higher and higher up the stems to replace the dead ones lost in the depths of the sand; thus new shoot and root systems are literally stacked one upon the other without ever necessarily becoming detached from the old dying or dead parental stock buried in the sand many feet below. Severance from the trunk or trunks below may come, how soon depending on the rate of destruction or decay beneath. When detachment below does occur, the branches above with their new roots then become really new and independent individuals.

There are interesting details and variations to the description just given. In the case of magnolia most arresting is the fact that sometimes the branches in the "stack" tend to be progressively larger in diamater toward the tip end. The explanation is not difficult; in a tree developing normally the more recent increments of the branch are smaller in diameter, so that ordinarily twigs or limbs taper toward the tip; but in the dune magnolia the more recent branches may be larger because they are fed by adventitious roots bigger and more efficient than those which supplied the earlier trunk or branches; then, too, the earlier or older parts although still connected may, because of burial or undue exposure, long since have been retarded if not actually stopped in their earlier growth. Other variations could be noted, but in the main the story of magnolia on these dynamic dunes is: a beginning in a mild habitat; a forcing upward by accumulating sand; a producing of adventitious roots which enable survival in deepening sand; but a dwarfing and spreading effect by the harsh aerial environment of the seaside.

Magnolias in Stable Dunes.—Magnolias do develop into large trees with single trunks even in the dunes. Two chains of events may lead to such trees in the end. One chain would involve the following links: an active magnolia dune could become stable; stabilization could, for example, be brought about by the recession of

PLATE I.

FIG. 1. (*upper left*)—Dwarfed magnolia on exposed dune. Beacon Hill, 20 miles east of Panama City.

FIG. 2. (*lower left*)—Magnolia holding dune in blow out. Long Beach.

FIG. 3. (*upper right*)—Dune invades pond, and stretches sweet-bay, grape, button bush, and others. Long Beach.

FIG. 4. (*lower right*)—Tree saw-palmettos due to removal of sand below. Long Beach.

PLATE I.

FIG. 1.—Magnolia exposed by undermining. Note that limb is larger toward tip. Long Beach.

FIG. 2.—Free slash-pine in rear, buried slash-pine with cone in front. Beacon Hill.

PLATE II.

the seashore, or could be brought about by the building up of a protective foredune, or a combination of both; in such an event a variety of trees and vegetation would establish themselves on the dune and in turn furnish shade and milder conditions for the magnolia; in this way a magnolia, caught in a formerly active dune and stunted by subsequent violence, might finally as the conditions ameliorated wind up as a tree. The foregoing is by inference. The second chain of events based on my observations goes as follows: along the coast behind the younger active dunes lie quiescent, older ones of geologic times.[4] In such dunes one finds predominating a mixture of oaks, hickories, and other hardwood trees and shrubs; in these hammocks developed on old dunes the soil is relatively rich and moist; the atmosphere, shady and humid; and in this kind of environment magnolias start easily from seed, and unless man or fire interferes, mature unmolested into trees comparing not very unfavorably with those of inland magnolia-beech climax forests.

Scrub Live-Oak.—Quercus geminata (scrub live-oak) is much more abundant and exists over a greater variety of sand dune conditions than the magnolia. It is not my intention to idicate that scrub live-oak requires a low moist area for germination. However, general observations and discovery of adventitious roots show that the scrub live-oak trapped and covered by sand dune movement reacts in a manner very similar to magnolia.

Sweet-Bay and Others.—Hammock or swamp species like *Magnolia virginiana* (sweet-bay), *Cephalanthus occidentalis* (buttonbush), *Ilex glabra* (gallberry), *Callicarpa americana* (French-mulberry), *Ilex vomitoria* (yaupon), *Muscadinia rotundifolia* (grape), and others climb advancing dunes apparently like magnolia and scrub live-oak. Although I suspect their presence on many, I have not actually seen adventitious roots on the stems of all these species except French-mulberry, yaupon, and grape. The grape using other plants as a stairway may persist independently long after its support succumbs to the sand invasion. In the very active dune areas I have seen the foregoing species mostly on or in the proximity of more or less protected leeward sides of the fast moving dunes as they advance over swamp and hammock vegetation.

Slash-pine.—It is not unusual to see dwarfed *Pinus caribaea* (slash-pine), with full sized cones, hobnobbing on tops of dunes with magnolias. The indications are that the pine also begins in low places

[4]Martens, J. H. C., "Sand and Gravel Deposits of Florida," *Florida Geological Survey, 19th Annual Report* (1928), pp. 33-123.

prior to appreciable building up on the part of the dune which heaps the sand up and around it later on. Its shrub-like appearance and persistence on dunes, however, require an explanation quite different. Although some trunks were laid bare downward ten or fifteen feet by shifting sands, I found no semblance of adventitious roots. These more or less stunted pines spread over the sand are really tops of trees that have managed to keep ahead of the sand. In the cases examined at least it appears that all absorption takes place through the original root system at or near the same moist level where the tree first established itself and where it functioned before its footing was buried by the advancing dune. Since the slash-pine apparently produces no roots on its upper trunk, it does not seem able, like magnolia and scrub live-oak, to form new individuals by stacking or fragmentation in the sand below. It appears, therefore, that any branch of pine which breaks or decays away from the parent plant must perish.

Saw-palmetto.—The indications are that many, if not all, of *Serenoa repens* (saw-palmettos) found on tops of active dunes likewise began their existence in low moist areas. Then by vertical elongation of the rhizome and by sending forth of new roots from this modified stem the saw-palmettos are able to stretch their necks above the piling sand. Sometimes after a period of upward growth the rhizome may curve downward along the sides of a dune. When subsequently the supporting sands are removed, naked saw-palmettos may remain in the former position as if transfixed. Those that grew erect will now stand straight as trees, and those that hung down the sides will remain as more or less graceful curves poised in mid-air.

SUMMARY

1. It has been shown that *Magnolia grandiflora, Quercus geminata, Serenoa repens, Callicarpa americana, Ilex vomitoria,* and *Muscadinia rotundifolia* keep their tops above invading sand by stem elongation and production of roots therefrom.

2. *Magnolia virginiana, Cephalanthus occidentalis, Ilex glabra,* and others are also able to persist in accumulating sand where coastal air conditions are not too severe.

3. Stems laid bare by winds revealed the facts that *Magnolia grandiflora* stacks new plants upon its old frame; that both *Magnolia grandiflora* and *Quercus geminata* may multiply into new individuals by the separation of formerly connected stems in the sand below.

4. On old stable dunes where the soil is rich and moist and the atmospheric conditions mild, *Magnolia grandiflora* may develop from seed, and barring catastrophe by man or fire, develop into normal trees and magnolia forests.

5. *Pinus caribaea* presents a stunted appearance not unlike *Magnolia grandiflora*. In contradistinction to *Magnolia grandiflora* and *Quercus geminata* its persistence in piled up sand seems not tied up with the ability to produce roots but with the continued use of its original absorptive roots.

6. The dwarfing or stunting of trees is related to the extreme air conditions of the coast; survival depends on the production of roots on the covered stems or the ability to continue absorption in spite of prolonged and extensive burial.

7. Some of the gawky tree palmettos (*Serenoa repens*) of the sea coast are plants once supported and made possible by sand accumulations but later left destitute of such buttressing.

THE DEVELOPMENT OF THE SOCIAL SCIENCES IN THE SOUTHEAST

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During the past two decades the social sciences have reached a new prominence in the colleges and universities of the Southeast. It is impossible now to report on actual enrollments, but certainly not far less than one in four undergraduates are at present taking courses in one or another of the specialized fields. More than 20,000 southern college students then, at the most conservative estimate, are being given more or less adequate training for the interpretation of the social realities. In an increasing number of southeastern schools, besides, students are being offered survey courses designed to summarize and inter-relate the findings of all the social sciences. The University of Florida, the Louisiana State University, the University of North Carolina and the University of Mississippi are among institutions which have developed such courses, and others are at work on similar materials.

Six leading southeastern universities are shown, in data assembled by Dr. Manning J. Dauer of the University of Florida,[1] to devote about one-fourth of their teaching forces to the teaching of the social sciences, and about one-fifth of the course offerings[2] in these institutions can be listed with the social sciences. Although inspection of catalogues suggests that the teachers' colleges and the smaller colleges place less emphasis upon the analysis of social and economic situations and processes, it remains true that even among these schools there has been notable advance since 1920. Estimating again, one might guess that perhaps one of every six college teachers in the Southeast is partly or entirely engaged in the teaching of the social sciences.

The profound readjustment of American attitudes after the World War appears to have given impetus to the social sciences. Economists and sociologists particularly found demand for expansion relatively great during the 'twenties. Then the deflation after the autumn of

[1]Dauer, M. J., Unpublished Manuscript, "Social Sciences in Six Southern Universities."

[2]This is in terms of separate subject matter courses. No figures are available in cases where courses offered are divided into two or more sections.

1929 raised new questions about the American culture and economy and, indeed, provided a new "boom" for the social sciences. Their recognition in Washington, first, at the hands of President Hoover and later, on a far larger scale, during the Roosevelt administration, contributed to the trend. New research organizations appeared all over the country, and old ones found their activities increased.

The Southeast has been a favorite field for research in the social sciences for many years. Foundations and other organizations of national scope have carried on many of their more impressive activities here and, since 1933, half a score of Federal agencies have added to the bibliography of new studies. Some of the more recently developed research techniques, especially in the field of sociology, have been given their first large-scale tests on southern situations. Perhaps these generalizations hold because nearly every paradox or dilemma of the times had some dramatic expression in the Southeast to attract the attention of specialists. Certainly no area has been given more intensive study by experts, nor has any other region had more attention from the general public.

Under the circumstances it is less surprising that the social sciences grew in the Southeast than that they grew no more rapidly. Their development in the region may not, on close examination, appear to have been based on a careful analysis of the needs of scholarship. In sociology, for instance, in 1938 only about one-fourth of the college teachers in the Southeast had a Ph.D. degree, and of those with the Ph.D. only about half had received their advanced training in sociology.[3] Eight instructors in the field had no training beyond the A.B. Moreover, a major interest in any field between "poultry sciences" and "student personnel administration" appeared to satisfy some institutions as a background for teaching sociology. Individuals trained in sixteen fields other than sociology are engaged as sociologists, including zoologists, classicists, agronomists, lawyers, poultry specialists, Spanish teachers, mathematicians, and philosophers.

Although the training of their personnel appears more adequate than this, other social sciences have functioned under serious handicaps in the Southeast. As Wilson Gee has shown,[4] college teachers

[3]Mann, D. M., Unpublished Manuscript, "Qualifications of Teachers of Sociology in the Southeast," prepared for the 1938 convention of the Southern Sociological Society.

[4]Gee, Wilson, *Research Barriers in the South* (New York: Century Co., 1932), Ch. IV.

of the social sciences in this region receive a third less pay than their contemporaries outside the Southeast for teaching approximately a third more class-hours per year. The salary differential, according to Gee, is about $1,200 per year at the professorial level.[5] Further, the place of research in the professors life appears debatable. Replying to Dr. Gee's question as to whether "research is a part of a professor's work in your institution, and a necessary accompaniment of good teaching," some presidents actually announced that research is deleterious, while others treated the question vaguely and only a minority were emphatically favorable in their answers.

Research in the social sciences has, in fact, financial support in only a few institutions in the Southeast. Most of the research done has been financed by the investigator himself, some outside governmental agency, or some one of the foundations. In sharp contrast to its large staff of relatively unprepared teachers and its low status as an instructional discipline, sociology in the Southeast appears to have had more outside help towards research than most of the other social sciences. This aid, however, has notably come from non-Southern sources.

One finds here an interesting contrast with the Southeast of the 'fifties, the hectic years before the Civil War. During the first half of the Nineteenth Century the social sciences apparently stood well with academic powers. The great DeBow poured out his social-economic studies from Louisiana University. Henry Hughes of Mississippi and George Fitzhugh of Virginia were publishing the first American volumes in the field of sociology. William H. M'Guffey, J. C. Calhoun, J. C. Nott, J. L. Cabell, John A. Smith, Francis Lieber, Jacob Cardozo, the three Tuckers, (George, Nathaniel, and Henry), Thomas Cooper, F. L. Hawks, C. E. A. Gayarré, Nathaniel Ware and a score of others were among American leaders in the emerging social science. In quantity and quality of product the social scientists of the Southeast compared well with those of other areas. If their publications generally fail to pass the modern test of objectivity, as much may be said of social scientists anywhere during the period.[6]

Today we find that in eighteen institutions in the Southeast there are faculty committees or other bodies whose task is to facilitate re-

[5]No doubt this differential in salaries extends through all fields. More adequate figures for a comparison are available in the case of the social sciences.

[6]Gee, *op. cit.*, Ch. II.

search in the social sciences.[7] In perhaps half of these there are funds available to finance research, generally through some specialized source such as the Agricultural Experiment Station. In more than eighty southeastern colleges and universities no funds are provided for research purposes. This, however, is not relatively as bad a showing as might be expected, since Dr. Gee has shown further that only one of every six American colleges outside the Southeast provided their social scientists with aids to research. In point of fact the "national average" in this respect is somewhat lower than the "regional average" of the Southeast, although the funds available here are generally much less than elsewhere.

In the matter of research leadership several institutions have made rapid progress. The University of North Carolina, Duke University, the University of Virginia, Louisiana State University, Vanderbilt and several others have done substantial work since 1920. Well-organized research institutes are functioning at North Carolina, Virginia and L. S. U., and comparable activities are carried on in the other institutions named. A half-dozen universities, including those named and the University of Florida, are responsible for the publication of journals devoted to publicizing the results of research in the social sciences.

The Institute for Research in Social Science at the University of North Carolina, organized in 1924, is important both for its pioneering efforts and the size of its accomplishment. Operating on an annual research budget of about $50,000, it has produced seventy volumes dealing with current social realities in the Southeast, has an additional ninety book-length manuscripts in its archives, and has in progress thirty-nine additional research projects. A decidedly incomplete list shows more than two hundred research articles published by members of the Institute since its founding. While the organization is primarily concerned with sociology, slightly more than half its published volumes were produced by specialists in other fields. It is largely because of the activity of the Institute that the University of North Carolina ranks among the first ten American universities in the field of sociology.

A second research institute based upon the field of sociology is the Institute for Research in the Social Sciences at the University of Virginia. Since 1926 this Institute has published more than thirty

[7]Gee, Wilson, *Social Science Research Organizations in American Universities and Colleges* (New York: D. Appleton Century Co., 1934), Ch. II. In some cases the committees are concerned with other fields in addition to the Social Sciences. There are also many specialized research committees in the other fields.

volumes summarizing research in the social sciences. The Bureau of Public Administration, collaborating with the Institute, has issued more than twenty titles dealing with public affairs in Virginia.

At Louisiana State University the Institute for Research in Southern Population and the Institute of Governmental Research have made considerable progress in recent years and the Department of Rural Sociology, largely a research organization, has an ambitious research program. These agencies have been well supported by funds from governmental sources as well as from the foundations. An imposing record of publication has appeared through the various departments in Duke University since that institution began its general program of expansion.

However, it would be impossible to summarize in the confines of this paper all the work done by the group of southeastern universities which have already established themselves as producers of research in the social sciences. Excellent work is under way or has been published by individuals in every institution of any size in the region, and in some of these there is prospect of further organization or coordination of research programs. The recently organized general university committee on research in the University of Florida, and the project research program to be associated with a Division of Social Sciences at the University of Mississippi, exemplify the progress being made.

In summary it may be said that at least quantitatively the social sciences have established themselves in the curricula of southeastern institutions. As to the quality of instruction and the qualifications of instructors less can be said. Especially in those smaller institutions where a single individual must teach in several specialized fields, it is doubtful that instruction can be carried on at a sustained high level. As a second generalization, we may observe that a few leading universities have already established themselves as research centers, while in most of the rest of the institutions lack of funds and heavy teaching loads combine to prevent any such development.

There is another proposition to be demonstrated regarding the development of the social sciences in the Southeast. Trends which are perfectly clear to the research specialist make impossible any assumption that the region is to have a placid future. While on the surface the Southeast faces only the same economic difficulties which have confronted it for many decades, the extraordinary prospective increase of white adult population in the Southeast, coupled with the admitted surplus of unskilled adult population in the areas to which Southerners used to emigrate, guarantee the existence of problems in the immediate future.

The agricultural economy of the Southeast has no apparent prospect for expansion, yet the rural population will grow very greatly within the next few years. Despite the fact that industry in the region is expanding comparatively fast, a glance at the arithmetic of population expansion convinces one that new industry is unlikely to make places for all the new working population. For our generation, the population of the Southeast will have a rate of increase of about fifty percent, and one doubts whether the nation can easily find economic space for them.

Here is a challenge for the social sciences. Freed from the necessity for introspection and purely verbal analysis which characterize their formative stages, the various specialties can offer, through realistic and factual study of the potentialities and the problems of the region, a substantial help towards solution of its chief difficulties. It is of course obvious that few "social problems" are ever "solved" in any final sense. It is clear, too, that neither the Southeast nor any other American area is likely to embark upon any total scheme of social planning. Yet it is also clear that already, through half a dozen channels, the efforts of the social scientists are being made available to the directors of public policy, in this region as well as in national affairs.

The precise role to be played by the social sciences in the development of the region can hardly be forecast, yet one may venture to say that they will develop in proportion to their usefulness. As a minimum estimate of that usefulness one may suggest their capacity for pointing out and demonstrating the character of the basic issues confronting the regional society. As another undeniably important task which they can undertake, we may consider the critical evaluation of programs proposed. If the specialist has not shone as a creator of positive goals and programs, he has already demonstrated his capacity for these two essential services. Southern leaders, whether congregated at the southeastern planning conferences carried on under various auspices, at informal gatherings, or at such meetings as those of the Governors' Conferences, are more and more aware of the importance of utilizing research and its results as an approach to their problems. If progress in this direction has been slow, it has apparently been sound. There are few of the social sciences which still face the task of demonstrating to the public and to responsible leaders that they can contribute much to the general welfare. What remains for them is the possibility of very great future development provided only that, realistically and in full recognition of the limitations of the "expert" approach, they proceed towards the clarification of the important issues of the times.

THE FLAT-TAILED WATER SNAKE

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The flat-tailed, or salt water snake [*Natrix compressicauda* (Kennicott)] apparently is restricted in its range to the salt marshes bordering Florida, and is found in greater abundance on the west coast of the state. It is singular for being one of the smallest water snakes, not exceeding a yard in length, and for being the only snake native to North America which exclusively frequents salt water. Its principal food consists of the salt water killifish (*Fundulus heteroclitus*) and other species which are abundant in shallow water. In captivity it will also take frogs, and sometimes toads. Strangely enough, one specimen now in my possession on one occasion swallowed a piece of raw beefsteak.

The name "flat-tail" is a misnomer. Actually the tail is quite well rounded and the flattening is almost imperceptible. The number of young, according to my observation, is small, being somewhat over a dozen, but one authority has told me of seeing a litter of forty-three.

This species seems usually to frequent the vicinity of mangrove bushes, in which it takes shelter when alarmed, and it often may be seen sunning itself among the branches. I have captured quite a number of these snakes in such places, and have observed their habits. Most of these I collected in an inlet of Tampa Bay at low tide at dusk, when they are most active. Some, however, were captured at night by means of a gasoline lantern. When dazzled by the bright light the reptiles could be approached quite easily.

In captivity the flat-tailed water snake is extremely hardy and will feed voraciously after a couple of days confinement. Live fish introduced into a cage of specimens will produce a turmoil. On one such occasion, one of my specimens made a dash for a fish and quite accidentally seized the head of one of his smaller companions, and, not seeming to realize this, proceeded rapidly to swallow the unfortunate creature. When the smaller snake had been swallowed half way, it was promptly disgorged, and went off catching fish as if nothing had happened.

Flat-tailed water snakes do not appear to remain constantly in the same vicinity, as I released one more than a year ago and re-

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covered it last month about three-quarters of a mile from where I let it go. It was easily recognized because half of its tail was missing, and it bore marks of one injury behind the head, and another farther down the side, which I had noticed during its first captivity.

In no other snake have I found so much color variation as with this species. There seem to be several distinct color phases as well as individual "sports." I believe that this does not occur to such an extent in any other American snake. The most frequent markings are a series of irregular brownish blotches on the back and smaller ones on the sides. These blotches usually fuse in such a way as to give the snake an irregularly cross-banded appearance. The ground color usually is a light, brownish gray; the abdomen is yellowish, with a central row of bright yellow, black-edged spots.

About fifty percent of the specimens have these blotches in a nearly straight line, while the others have them in zig-zag fashion, following no definite plan. The eyes and tongue are coppery red. A bright reddish orange form frequently occurs, with very faint markings. On such specimens the spots on the abdomen are margined with red instead of black. When lying in shallow water, these snakes have reminded me of strips of red inner tube. On one such marked specimen which I studied the skin between the scales was dark green. Except for the unusual color, the red phase does not differ from the typical form.

Two examples of a different phase which I collected were especially beautiful. They were a dull, blue gray, with rosy red blotches. The abdomen was white, with two pink stripes. I have occasionally found red specimens with the abdomen marked in this way. Also a pale brown phase occurs, with faint blotches, as well as pale gray examples, with irregular black bands across the upper surface.

All these forms may be divided into two groups: Those in which the wavy banded appearance continues the whole length of the body, and those in which the blotches fuse into length-wise stripes on the neck. One example which I captured had these stripes running the whole length of the body.

The variation is quite as extensive, if not exceeding that of its near relative, the banded water snake (*N. sipedon pictiventris*). Cope, who describes this snake, names some of the different color phases as separate subspecies, but as these different forms frequent the same localities and show gradations between the phases, I am inclined to differ with this opinion.

PRELIMINARY LIST OF MYXOMYCETES FROM ALACHUA COUNTY

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There are very few published records of the occurrence of Myxomycetes in Florida although occasional collecting trips during the past several years have revealed a wealth of forms waiting to be classified. The State furnishes many suitable types of habitat for this group of organisms.

The hardwood hammocks of Alachua County are especially rich in number of individuals and variety of species but all sorts of habitats have contributed their quota. It seems quite probable that this list contains only a small portion of the species present and further collecting should reveal many more representatives of this interesting group.

The nomenclature used by MacBride and Martin in "The Myxomycetes" is followed in this paper. Specimens of all the species listed have been deposited in the Herbarium of the Florida Agricultural Experiment Station, at Gainesville.

SUB-CLASS I. EXOSPOREAE

1. *Ceratiomyxa fruticulosa* (Muell.) Macbr.
   On rotten wood:—very common and especially abundant during the rainy season and after the fall showers; very variable.

SUB-CLASS II. MYXOGASTRES

Order 1. Physarales

2. *Fuligo septica* (L.) Weber.
   On debris of all kinds:—very common and conspicuous.

3. *Fuligo megaspora* Sturgis.
   On rotten wood:—rare.

4. *Badhamia rubiginosa* (Chev.) Rost.
   On fallen leaves, especially oak:—common on fallen leaves and often covering small twigs in high hammock.

5. *Physarum albescens* Macbr.
   On fallen leaves:—very rare.

6. *Physarum bivalve* Pers.
On living or dead leaves:—frequent in rich hammocks.

7. *Physarum bogoriense* Racib.
On fallen leaves and dead stems:—common in rich hammocks.

8. *Physarum cinereum* (Batsch.) Pers.
On grass blades and living stems:—often conspicuous in lawns.

9. *Physarum flavicomum* Berk.
On logs:—locally abundant.

10. *Physarum globuliferum* (Bull.) Pers.
On rotten wood:—common in low hammocks.

11. *Physarum gyrosum* Rost.
On rotten wood and debris:—common, often in large colonies; frequent on sodden paper around rubbish piles.

12. *Physarum leucopus* Link.
On wood and leaves:—rare.

13. *Physarum melleum* (Berk. & Br.) Mass.
On fallen leaves:—common in rich hammocks, especially on Magnolia leaves.

14. *Physarum nucleatum* Rex.
On wood:—rare.

15. *Physarum nutans* Pers.
On various substrata:—not common although frequent elsewhere.

16. *Physarum polycephalum* Schw.
On stumps and logs:—common on well-decayed hardwood stumps.

17. *Physarum pusillum* (B. & C.) List.
On rotten wood:—frequent, in small colonies in rich hammocks.

18. *Physarum roseum* Berk. & Br.
On fallen leaves:—rare, collected only once.

19. *Physarum serpula* Morg.
On living leaves:—not common, at edges of hammocks.

20. *Physarum tenerum* Rex.
On rotten wood and twigs:—not rare but inconspicuous.

21. *Physarum viride* (Bull.) Pers.
On wood and debris:—very common.

22. *Craterium paraguayense* (Speg.) List.
On leaves, twigs, etc.:—frequent in rich hammocks especially on fallen masses of Spanish moss.

23. *Craterium leucocephalum* (Pers.) Ditm.
On various substrata:—very common under many sorts of conditions.

24. *Trichamphora pezizoidea* Jungh.
On wood:—rare, collected only once.

25. *Physarella oblonga* (B. & C.) Morg.
On wood:—in hammocks, not common.

26. *Mucilago spongiosa* (Leyss.) Morg.
On dead stems:—frequent in high hammocks.

27. *Didymium clavus* (Alb. & Schw.) Rabenhorst.
On wood:—rare, collected once.

28. *Didymium complanatum* (Batsch.) Rost.
On living leaves:—rare, collected once in open hammock.

29. *Didymium melanospermum* (Pers.) Macbr.
On wood:—rare.

30. *Didymium squamulosum* (Alb. & Schw.) Fr.
On wood:—rare, collected once.

31. *Didymium xanthopus* (Ditmar) Fr.
On wood:—common in rich hammocks.

32. *Diderma effusum* (Schw.) Morg.
On twigs and leaves:—common in open high hammocks, often covering large areas.

33. *Diderma testaceum* (Schrad.) Pers.
On debris:—rare and in small colonies.

Order 2. Stemonitales

34. *Diachea bulbillosa* (Berk. & Br.) List.
On leaves:—rare, collected once.

35. *Diachea leucopoda* (Bull.) Rost.
On various substrata:—common, especially in gardens.

36. *Diachea radiata* G. List. & Petch.
On weeds:—rare, collected once.

37. *Stemonitis axifera* (Bull.) Macbr.
On rotten wood:—common in hammocks.

38. *Stemonitis fenestrata* Macbr.
On wood:—rare, collected once.

39. *Stemonitis flavogenita* Jahn.
On wood:—not common, in hammocks.

40. *Stemonitis fusca* Roth.
On wood:—very common on logs, especially near streams.

41. *Stemonitis pallida* Wingate
On wood:—rare, collected once.

42. *Comatricha pulchella* (Bab.) Rost.
On leaves:—common in hammocks.

43. *Comatricha pulchella* var. *gracilis* List.
On leaves:—rare.

44. *Comatricha nigra* (Pers.) Schroet.
On leaves:—frequent on live-oak leaves in hammocks.

45. *Comatricha typhoides* (Bull.) Rost.
On leaves:—very common, especially in dry woods.

46. *Clastoderma debaryanum* Blytt.
On very rotten wood:—not so rare as inconspicuous.

47. *Lamproderma arcyionema* Rost.
On rotten wood:—apparently rare here.

48. *Lamproderma violaceum* (Fr.) Rost.
On decaying wood:—rare, collected once.

Order 3. Liceales

49. *Lindbladia effusa* (Ehr.) Rost.
On barkless pine wood:—common on fallen loblolly pine logs.

50. *Cribraria dictydioides* Cke. & Balfe.
On logs:—very common near water, colonies often large.

51. *Cribraria intricata* Schrad.
On logs:—common in moist hammocks.

52. *Cribraria cuprea* Morg.
On wood:—rare, collected once.

53. *Cribraria tenella* Schrad.
On wood:—not rare, in hammocks.

54. *Enteridium rozeanum* Wing.
On wood:—not common.

55. *Dictydium cancellatum* (Batsch.) Macbr.
On wood:—very common on moist logs in hammocks in colonies often exceeding a yard in length.

56. *Dictydiaethalium plumbeum* (Schum.) Rost.
On rotten wood:—collected once in an oak log in rich hammock.

57. *Tubifera ferruginosa* (Batsch.) Gmel.
On rotten wood:—common especially on pine stumps in low hammocks.

58. *Tubifera stipitata* (Berk. & Rav.) Macbr.
On bare wood:—common in low hammocks.

59. *Reticularia lycoperdon* Bull.
On wood:—rare on decorticated logs in open.

60. *Lycogola conicum* Pers.
On rotten wood:—rare and inconspicuous in moist hammocks.

61. *Lycogola epidendrum* (L.) Fr.
On wood:—very common on rotten wood in low hammocks.

62. *Lycogola exiguum* Morg.
On wood:—frequent on rotten wood in hammocks.

63. *Lycogola flavo-fuscum* (Ehr.) Rost.
On stumps:—rare, usually on pine stumps in hammock.

Order 4. Trichiales

64. *Ophiotheca Wrightii* B. & C.
On bark:—frequent on the under-side of hardwood logs on damp ground.

65. *Perichaena depressa* Libert
On bark:—common on moist oak bark, especially in fall and winter.

66. *Arcyria cinerea* (Bull.) Pers.
On wood:—common frondose wood in hammocks.

67. *Arcyria denudata* (L.) Wettstein.
On wood:—very common in hammocks in fall.

68. *Arcyria digitata* (Schw.) Rost.
On wood:—common on moist rotten wood.

69. *Arcyria incarnata* Pers.
On wood:—rare in low hammocks.

70. *Arcyria magna* Rex.
On wood:—rare on logs usually near streams.

71. *Arcyria nutans* (Bull.) Grev.
On wood:—frequent on logs in high hammocks.

72. *Trichia decipiens* (Pers.) Macbr.
On wood:—rare on bare pine logs.

73. *Trichia favoginea* (Batsch.) Pers.
On wood or bark:—common under oak logs in fall.

74. *Trichia persimilis* P. Karst.
On wood:—rare under logs.

75. *Hemitrichia serpula* (Scop.) Rost.
On wood:—very common on logs, often under oak bark in fall and winter.

76. *Hemitrichia stipata* (Schw.) Macbr.
On wood:—rare on logs in low hammocks.

77. *Hemitrichia stipitata* (Mass.) Macbr.
On wood:—common on logs and bark in fall.

78. *Hemitrichia vesparium* (Batsch.) Macbr.
On wood:—common on logs and stumps in moist hammocks, especially in fall and winter.

79. *Calonema aureum* Morg.
On wood:—rare, under logs.

GEOGRAPHY AND THE SOCIAL SCIENCES

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Geography is primarily an interpretation of the distribution, life, and activities of people in the various regions of the world. In making such an interpretation, a geographer draws on certain results of such sciences as geology, meterology, anthropology, and climatology, because they concern the environment of his central figure—Man.

In order to understand a people it is also essential that we understand thoroughly their history. The geographer, therefore, studying a present-day civilization regards its history as a succession of geographic factors embodied in events. History is really geography set in motion. What is today a factor of geography becomes tomorrow a fact in history. The two sciences cannot be held apart without materially decreasing the value of both.

The study of physical features as a factor in history has very unfortunately been brought into disrepute due primarily to extravagant generalizations based on insufficient data. Some geographers, even today, are often apt to use one factor to the exclusion of all others. A geologist will be likely to stress the physical features. A meteorologist is apt to claim that weather is an all-powerful force directing human development. This is a form of narrow-mindedness to be explained at least partially by the fact that the specialist in any one field is of course better able to see the significance of the factors in his own field. Geography, however, is a study of a large group of influences at work at the same time as well as influences which have operated at different times. Some of the factors operate in one direction, some in another. A certain factor may be extremely important at one time, but an entirely different one may be released from dormancy by the expansion of the known world or by invention or by social change, and may become the most important factor at a later period.

These complex geographic influences cannot be analyzed, nor can their strength be estimated except from the standpoint of evolution. It must be realized that all the geographic relations of man are subject to the laws of development. The physical environment may be favorable to one stage of human development but entirely adverse to another, and vice-versa. For instance, a small isolated and pro-

tected environment like that of Greece encouraged the precocious growth of a wonderful civilization but later this same physical environment hampered progress and expansion and arrested the development of the people. For much the same reasons the highly developed trade of the Baltic, which gave wealth and prominence to Lübeck and other Hanse towns of Northern Germany from the 12th to the 17th century, lost its importance when the Atlantic Ocean became the maritime field of history. A true geographer, therefore, while studying a given combination of geographic forces must be prepared for tremendous readjustments and new relationships after any marked turning point in the economic, cultural, or world relations of a people.

The extreme complexity of the geographer's problem does not end here. Human development as influenced by geographic environment is a natural process and involves the cumulative effects of diverse forces operating imperceptibly but persistently through vast periods of time. Slowly and deliberately does geography engrave the sub-titles to a people's history.

In every problem in the study of people there are two major factors; stated in various ways, these are: heredity and environment, man and his geographic conditions, internal forces of race and external forces of nature.

The geographic element has operated strongly and persistently during the long history of human development—it is a stable force—it never sleeps. The extent to which certain forces are recurrent throughout history is largely due to the persistent influence of physical environment.

The difficulty of separating either geography or history from other subjects cannot be illustrated better than by considering the relation of one to the other. For example, the geographical variation of life types in relation to differing environments comes about commonly by way of migrations through space which are recorded in space or time. Actually they are recorded in both. We may well look upon the variety and change incident to geographical distribution, and to development or evolution through time, as among the greatest conceptions regarding the world about us.

So significant do the points of view of geography and history appear, that, at a time when citizenship carries real responsibility for knowledge, it seems reasonable to take the view that no person should be considered educated until he has experienced the actual construction of a map representing the elements of the distribution of a significant physical phenomenon and in addition has engaged

in following out the development, or history of a social phenomenon or idea illustrating sequence in time.

Whatever the complications arising from the interlocking of geography and of history with a great number of other fields, each of the two subjects has made its contribution in the interpretation of data in these other areas of thought. Geography has defined variation of materials and conditions in space. History has been the measure of time and change, touching all things inanimate, animate, and human. The record of its movement must be examined by methods comparable in exactness, organization, and purpose of interpretation to those of the sharply defined natural sciences. Whether or not the modes of procedure are as simple and as clearly defined as those of physics, they are not less important, and should be used as far as we can interpret them.

The natural geographic conditions may be clearly shown to have a determining influence upon national economic development and national character. They play a very significant part in the attitudes of the people. There should be developed in each of the enlightened countries a greater intelligence and a more kindly sympathy in the minds of those who sit in council representing the peoples of the different nations.

An appreciation of the geographic settings in the different parts of the world where people are living should lead to an understanding of economic and social conditions under which the people live. Through an intelligent appreciation of the historic background of a people and the geographic setting where they are enacting their great human dramas, there should develop an intelligent sympathy for this people.

This is not an idle dream, nor is it an intangible goal. The ideals upon which it rests may be taught in the classrooms to little children where they are working together. They may be incorporated in the training of all teachers. They should be presented in the colleges and universities very effectively, and should be incorporated in the training of all those entering the diplomatic service and of those who seek public office at home or abroad.

No interpretation of history can be intelligently made without an appreciation of the setting where the historic dramas have been enacted. No intelligent interpretation can be made of the economic problems of today unless due consideration is given to the natural conditions under which the people concerned are living. No great business can be properly administered without an appreciation of economic conditions throughout the world. The social life of a peo-

ple reflects an intimate relationship to their surroundings. Even the works of literature and music reflect the influence of environment. Individual groups develop somewhat differently because of biological inheritance and environmental conditions, and we must recognize that problems of international relations come to us naturally as different peoples have populated the different sections of the earth.

In stressing the significance of the natural factors and forces influencing social organization, the importance of the influence of people themselves on other people must never be forgotten nor underestimated. The natural environment is powerful in shaping human life, but life itself transcends all other influences. Like myths, fetishes, totems, and religions, so also do forms of government appear and reappear in all tribes and all peoples from the beginning of history without the slightest mark of collusion. Nevertheless, the stages of human evolution are in a great degree determined by the location of the countries, their surface forms, mineral and fuel resources and by their climate, flora and fauna.

A vivid concept of the structure of a country is the main means of binding historical knowledge into a more complete concept. Events, dates, narrations, and characters are facts mingled in hopeless confusion without an adequate knowledge of geography. But having such a knowledge, we are able to follow the march of armies, migrations, the extension of empires by conquest and colonization, and retain in the mind all intrinsic features. The study of history without the continual use of the best maps is an extravagant use of time.

Geographic science attempts to help recognize and trace the actions of some of the recurrent economic and social forces that have physical relationships. Geography does not attempt to analyze civilizations. It aims to provide that geographical point of view without which a study of mankind is unrelated to this earth. It is often claimed that geography deals with fixed elements because the earth remains substantially the same from one generation to another. Nothing is further from the truth. The physical world changes constantly in its meaning to man because of the constant change in his technology.

The more that is learned about geology and physiography, the fuller must be the interpretation made by the geographer in terms of the human beings who live on and make use of the land. Advances in meteorology, climatology, podology, and other branches of scientific and technical learning result in a wealth of detailed material, which the geographer must use and integrate in order that it may be most valuable in bringing about an understanding of the individuality

of regions and in the solving of their problems. The same is true in the field of social studies. Archaeology, anthropology, history, and sociology have all added to our knowledge of the background which is absolutely essential in understanding present-day regional problems. Studies of the economic and political status of modern culture are equally essential to the understanding of regional and inter-regional problems.

Up to the present, the development of specialized knowledge in the fields of the physical sciences and the social sciences has to a large extent been from the standpoint of the topic or the subject of investigation. Topical knowledge in each of these fields has grown to such an extent that it is utterly beyond the ability of an individual to be familiar with it. Modern society, however, requires that this knowledge be integrated upon some basis so that it can be used effectively. In attempting to do this, the geographer sets up regions within which the complexity of interrelated topical knowledge is so coordinated as to make possible effective interpretation. If I were asked for a definition of geography, my answer would be that it is the science of regional interpretation.

The first problem is to find regions within which specific resources group themselves in such a way that man's adjustment or maladjustment to them can be readily distinguished and studied in detail. Within such a region problems are investigated so as to permit expert treatment. This would result in a division of the state into a number of regions, each of which would be dealt with in a way which would show how to improve the adjustments of population to the local environment and show how to make economical use of the resources of that region. It is quite possible that a region of this type would become, through intelligent planning, less and less diversified through the elimination of sub-marginal and marginal lands and industries. It is also probable that a region of this type would tend to become specialized and less self-sufficing, provided of course that the economic laws of comparative advantages were allowed to operate. In the end, the result would be that each region would become increasingly aware of its potentialities through a more proper evaluation of intra- and inter-regional resources. By this process, each region would become increasingly dependent upon the other regions of the state. Ultimately, this would increase state cohesion, which of course is certainly desired.

Regionalism is the grouping of social, governmental and economic factors to such an extent that a distinct consciousness of separate identity within the whole, a need for autonomous planning, a mani-

festation of cultural peculiarities, and a desire for administrative freedom are first, theoretically recognized, and then, actually put into effect. It is really a self-conscious process. As the creative state takes the place of the police state, as the nation becomes aware of its resources, both natural and human, and the necessity of serving and using them in the national interest, governmental plans—including municipal, county, state and federal—will transcend existing political jurisdictions and will usually exhibit regional peculiarities. This can be very readily seen by observing the problems with which government has had to deal during the present period of depression and reconstruction.

In the social sciences, one of the chief considerations would seem to be the regional peculiarities or characteristics that peoples have adapted, employed, or discarded. To understand and to appreciate them fully requires expert analysis, description, and comparison, region by region. The geographer provides a system of rationality for a complex of facts and relationships which otherwise would receive mere empirical descriptions.

Geography is not by any means a new science. It may be considered, in a sense, the mother of several of the sciences, and its field has been cultivated with greater or less persistence from the beginning of time. In spite of its age, or perhaps due to its age, it requires frequent re-statement to keep pace with the modern developments the younger generation of sciences has made. The field of geography has always been the interpretation of physical and human phenomena in relation to areal units or regions. The development that has taken place in the physical sciences and the social sciences has continued to provide factual material of the utmost importance to the geographer. Not only must geographical thought be revised in the light of these contributions, but it has been necessary to increase the content and detail of its subject-matter and re-state its objectives. This has come naturally with the advance of civilization.

Geographical teaching in physiography, climatology, meteorology, soil science, etc., involves human as well as physical points of view. As regards regional interpretation, geography is the one subject that provides it systematically.

Geography brings the facts together regionally. It does not, however, merely recombine data from other sciences. It goes further since its main purpose is regional analysis and correlation. Such syntheses help social groups understand and appreciate their limitations and possibilities. They also help governments function in-

telligently. No one discipline can furnish the whole analysis, however. Each scholar is limited in his mastery to a given technique or a group of techniques. In the case of a limited number of specific problems and regions a geographer may comprehend human relationships in their fullest economic, social and political aspects, but a complete expression is beyond the power of a single discipline.

Geography has been called a science, an art, and a philosophy. I am inclined to believe that, although geography has long been recognized as an essential science in European universities, and finally recognized and accepted in this country, the greatest value lies in its interpretative aspects. In other words, geography is most significant as a philosophy, or as a way of thinking, regarding man and his environmental relationships.

Geography is most valid when it ceases to be a device for dealing with the problems of geographers and becomes a point of view cultivated by geographers for dealing with the problems of man.

STUDIES OF FORAMINIFERA FROM SEVEN STATIONS IN THE VICINITY OF BISCAYNE BAY

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Local faunal lists of Foraminifera from shallow waters adjacent to the coast of Florida are lacking, with the exception of Cushman's studies of Foraminifera from the Tortugas area.[1] Flint[2] recorded some species from Florida waters, and Cushman[3] in his monograph has listed species from a number of Florida localities, but these records are scattered through several volumes and are difficult of access.

Through the courtesy of Jay F. W. Pearson and E. M. Miller of the University of Miami, I received data and bottom samples from the seven University of Miami stations listed in the accompanying table.

Sixty one species of Foraminifera representing twenty-three genera and eleven families are here listed from these seven stations. The Miliolidae are predominant with six genera and twenty-eight species. The Peneroplidae are represented by five genera, but each genus by very few species. Six families are represented by only one genus.

In the order of abundance of species, station 14 stands first with forty-one species. This station is subject to tidal effects and some species present may not necessarily be indigenous to this locality. The specimens shown, however, do not show signs of wear due to movement over the bottom and it is believed that this is the normal habitat of most of the species listed.

Station 16 shows a total of thirty-one species. The flats lying east of this station probably afford a protection similar to the protection afforded station 14. The depths and temperatures of these stations are about the same. The species present in the two, however, show certain differences. In station 16, individual specimens of each species are much more plentiful than in station 14. The Peneroplidae are represented by more and larger individuals in station 16 than in station 14 or in any other station.

[1]Cushman, J. A., "Shallow-Water Foraminifera of the Tortugas Region," *Carnegie Institution Publication No. 311,* (1922).

[2]Flint, James M., "Recent Foraminifera," *Annual Report United States National Museum,* (1897).

[3]Cushman, J. A., "The Foraminifera of the Atlantic Ocean," *United States National Museum Bulletin No. 104,* (1930).

TABLE 1

Occurrence of Species

(A—abundant; C—common; R—rare; x—present)

Species	Station Number						
	14	15	16	17	18	19	20
Textularia candeiana d'Orbigny	R						
Textularia floridana Cushman	R		x				
Textularia mayori Cushman	R						
Valvulina oviedoiana d'Orbigny	R	R	C	R			C
Clavulina tricarinata d'Orbigny	R	R	R	R	R	R	C
Clavulina nodosaria d'Orbigny		x					
Quinqueloculina agglutinans d'Orbigny		C	C	C		R	C
Quinqueloculina bidentata d'Orbigny	R	C	C	R		R	C
Quinqueloculina lamarckiana d'Orbigny	C	C	C	C	R		C
Quinqueloculina polygona d'Orbigny	R		R	R			
Quinqueloculina poeyana d'Orbigny		R	R	R		R	R
Quinqueloculina striata d'Orbigny			R				R
Quinqueloculina funafutiensis (Chapman)	R		R		R	R	R
Quinqueloculina tricarinata d'Orbigny	C		C	C			
Quinqueloculina columnosa Cushman	x			x			
Quinqueloculina fusca? H. B. Brady	x						
Massilina crenata (Karrer)	x						
Spiroloculina antillarum d'Orbigny	x						
Spiroloculina sp.	x						
Hauerina bradyi Cushman	R						
Triloculina linneiana d'Orbigny	C	C	C	R		R	C
Triloculina quadrilateralis d'Orbigny	R	R	R	x		R	C
Triloculina rotunda d'Orbigny	R	R				R	R
Triloculina carinata d'Obigny			R	R	x	x	R
Triloculina trigonula (Lamarck)		R		x		x	R
Triloculina tricarinata d'Orbigny		R	x			x	
Triloculina circularis Bornemann		R	x	x		R	
Triloculina bicarinata d'Orbigny	R						
Triloculina suborbicularis d'Orbigny	x			R			
Triloculina planciana d'Orbigny	x						
Triloculina labiosa d'Orbigny				R			
Triloculina oblonga (Montagu)			x	R			
Pyrgo denticulata (H. B. Brady)				R	R		R
Pyrgo subsphaerica (d'Orbigny)	R	R					R
Vertebralina cassis d'Orbigny	R					R	
Vertebralina cassis var. *mucronata* d'Orbigny	R		R				
Elphidium advenum (Cushman)	R	R				R	C
Elphidium lanieri (d'Orbigny)			x				
Elphidium poeyanum (d'Orbigny)	R	R			R	R	
Elphidium sagrum (d'Orbigny)		R	R	R	R	R	A
Peneroplis pertusus (Forskål)	R		R		R	R	R
Peneroplis proteus d'Orbigny	R	C	C	C		R	C
Spirolina arietinus (Batsch)	R			R			R
Monalysidium politum Chapman							x
Archaias angulatus (Fichtel and Moll)	C	A	A	C	C	R	C
Archaias compressus (d'Orbigny)		R	R				
Sorites marginalis (Lamarck)	C	R	R			R	C
Borelis pulchra (d'Orbigny)	R		R	R			
Discorbis auberii (d'Orbigny)							x
Discorbis bertheloti var. *floridensis* Cushman			x				
Discorbis candeiana (d'Orbigny)			x				
Discorbis floridana Cushman	x				x		
Discorbis mira Cushman	C	R	R	R	R	R	C
Discorbis orbicularis (Terquem)			x				
Rotalia beccarii (Linnaeus)	x						
Rotalia rosea d'Orbigny	C		C	C			
Siphonina pulchra Cushman	x						
Amphistegina lessonii d'Orbigny	C						
Cibicides refulgens Montfort	x						
Planorbulina acervalis? H. B. Brady				x			
Planorbulina mediterranensis d'Orbigny	R					R	

TABLE 2

DESCRIPTION OF STATIONS

No.	Location	Depth (ft.)	Temperature	Character
14	3½ mi. WNW of Soldier Key	12	25°C	Growth of eelgrass on bottom of medium coarse quartz sand with numerous mollusk fragments. In a bay protected by flats to the east but subject to east and west tides.
15	3½ mi. W of Soldier Key	12-15	24°C	Bottom clean quartz sand with numerous mollusk fragments; no eelgrass; Sponges and *Xiphogorgia* present; *Centrechinus* characteristic of the station. Protected in a bay behind Soldier Key flats.
16	1 mi. E of Soldier Key	10-12	24.5°C	Bottom clean coarse quartz sand, some fine quartz sand, numerous small mollusks and mollusk fragments; old coral bases protruding and forming attachment surfaces for numerous Gorgonians. On the open ocean side but somewhat protected by flats to the east.
17	3/4 mi. E of Ragged Key No. 3	8-9	26.5°C	Bottom hard; of medium fine, clean quartz sand; numerous finely broken coral and shell fragments; Gorgonians numerous. On ocean side, unprotected.
18	1/8 mi. S of Biscayne Key	1-2	26°C	Bottom soft; fine quartz sand, very limey; numerous broken mollusks and Gorgonia fragments; some eelgrass. Flats exposed at low tide.
19	3½ mi. E of Cape Florida	18-20	?	Bottom soft; medium fine quartz sand; calcareous mud; considerable eelgrass. Open water, unprotected.
20	3½ mi. ENE of Black Point	9-10	26°C	Bottom soft; coarse quartz sand; impure lime fragments; numerous mollusk fragments; Sponges, Annelids and Crustacea present; no Gorgonians. In a bay protected from open water.

Station 17 and station 20 show an almost equal number of species, the former having twenty-six and the latter twenty-five. The depths of water and the temperatures of these stations are about the same. Faunally these two stations are somewhat alike but the individuals of station 20 are largely unbroken whereas in station 17 many of the specimens show signs of wear. Peneroplidae in both these stations tend to be small. Quiet water forms such as the genera *Discorbis* and *Elphidium* are common in station 20 but rare in station 17.

Station 15 contains eighteen species; but the bulk of the individuals are Milioidae and Peneroplidae. *Archaias angulatus* (Fichtel and Moll) and *Quinqueloculina lamarckiana* d'Orbigny are most common.

Station 19 is the deepest of the stations sampled. Of the twenty-one species listed from this station, none are common and most of them are very rare. The Peneroplidae, common in all other stations, are almost absent and most specimens appear worn. *Archaias angulatus* (Fichtel and Moll), common and abundant in all other stations, is absent here. The Miliolidae are represented by eleven species but individuals of each species are very few in number. Study of additional samples from this station would be desirable.

In view of the fact that station 18 is sometimes exposed, it is very doubtful whether or not any of the specimens listed from that station ever lived there. Most of the specimens show signs of wear and many are broken.

Of the seven stations, five vary only slightly in depth, temperature and bottom conditions. Station 19 alone shows a marked difference in depth and bottom. Station 18 is excluded because it probably does not represent living conditions for most of the species found there. We would expect to find that the species from these five similar stations correspond closely both as to kind and abundance. It is therefore of interest to note that only nine of the sixty-one species listed occur in all five stations. Only two species are found in all seven stations. Twenty-two of the species are recorded for but one station. No two stations show the same assemblage of species or the same degree of abundance of individuals. It is evident therefore that Foraminifera are susceptible to very slight ecologic differences.

Faunal studies such as this have a direct application to the work of the geologist in stratigraphic correlation. The Florida peninsula has been inundated by the sea many times. Such submergences were not of the nature of a vast tidal wave. The land subsided or the height of water in the sea was raised or perhaps both, but this change

was very slow. We therefore have shore line conditions very gradually moving progressively landward and the older strand lines being slowly covered by deeper waters. When a maximum of submergence had been reached, the sea slowly retreated and a reversal of the above process took place. To further complicate the depositional picture, we very often find that a submergence cycle may be marked by an advance and then a partial retreat, in other words an oscillating sea. The sediments left by one cycle marking a maximum advance and retreat of the sea constitute a geologic formation.

The geologist concerned with the mapping and interpretation of the deposits of the geologic time units is known as a stratigrapher. For many years the stratigrapher has relied solely upon paleontologic evidence for his interpretations. The presence or absence of an index fossil or group of fossils has been the deciding factor in determining the stratigraphic position of any deposit. An index fossil is one that has a comparatively short vertical time range and wide geographic distribution. I do not wish to infer that index fossils are not valuable, but I do believe that interpretations based entirely upon index species are susceptible to error and that information based on more detailed studies must be used before a true picture of our geologic history can be produced. Our present knowledge would seem to indicate that index fossils are probably more reliable in pre-Tertiary deposits than in Tertiary sediments. Cushman has explained this by postulating that the rate of evolution has been accelerated since the beginning of Tertiary deposition, and adaptation to ecologic changes is more pronounced in these than in the older formations. Whatever the explanation, the fact remains that proper correlation of Tertiary deposits is very difficult and that Tertiary paleogeography is still in an extremely confused state.

The confusion that now exists is very largely due to the fact that proper allowances have not been made for the different facies present in any formation. Two reasons may be given for such errors. In the first place we have not had and still do not have the fundamental data necessary in order to make such allowances, and secondly many stratigraphers have stubbornly refused to recognize the necessity for making the allowances. Our interpretations of the past are of course limited by our experiences in the present. The man who is best versed in the conditions existing today in our present oceans is best fitted to interpret the history of the oceans of the past. The data essential to explain living conditions either in the sea or on land cannot be assembled by any one class of workers. The biologist, the chemist, the physicist, and the engineer must all contribute. We

must know not only what animals lived where, but also their habits and structural peculiarities. In the many faunal lists that have been compiled, there is an appalling paucity of these vital data. We must also know the actions of tides and currents, the mechanics of the transportation of the sediments and the chemical constituents of the water. With these data in hand, it will be possible to begin to learn what effect a particular environment is having and has had upon the fauna. This information can then be used by the geologist in arriving at a proper interpretation of geologic formations and the life that they contained.

The exposed geologic formations of Florida are all of Tertiary and younger age. Tertiary rocks extend below the surface to nearly three thousand feet in parts of the state. We are fairly familiar with the older Tertiary Eocene rocks and their relationships in the peninsula and into Georgia; but there is still considerable doubt as to the exact relation that these have with the Eocene farther west and northward. In the younger formations there is even more doubt as to the exact correlation of deposits even within the peninsula. The Pliocene beds of south Florida are faunally the richest in North America. Pliocene deposits are also well developed in northeast and east central Florida. These two have been correlated by Cooke and Mossom; but we are by no means sure of the exact relation that these bear to one another. The answer to that question can be obtained only through a careful study of the ecologic conditions existing at the time those deposits were laid down. Detailed knowledge of our recent faunas will contribute greatly toward arriving at a satisfactory answer to that and to many of Florida's other problems in geologic correlation.

TESTS FOR DETERMINING PRIME FACTORS

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It is often desirable to have a rapid and quite uniform method for determining by trial the prime factors of a number, particularly a number of many digits. Methods are in common use for determining divisibility by 3, 9, and 11; but satisfactory methods applicable to 7, 13, 17, 19, 23, 29, 31, etc., certainly are not well known. Such methods to be useful must involve processes which are less laborious than the process of division.

Now, all the primes above 5 end in the digits 1, 3, 7, or 9; so it is desirable to have a uniform rule which may be applied separately to each of those four terminal digits. First, let us consider the case of numbers whose units digit is 1. Let $10n + 1$ represent any such number, n being a positive integer. Then, the following theorem may be proved algebraically:

Theorem 1. *If any whole number,* $10t + u$, *where* t *is any positive integer and* u *is the digit in the units place, is divisible by* $10n + 1$, *then the number* $t - nu$ *is also divisible by* $10n + 1$.

Now, we have by assumption,
$10t + u = p\ (10n + 1)$, where p is integral. Then,
$10nt + nu + t = np\ (10n + 1) + t$, and
$t(10n + 1) + nu = np(10n + 1) + t$; or
$t - nu - (t - np)\ (10n + 1)$. But $t - np$ is integral; hence, $10n + 1$ is a factor of $t - nu$, and the theorem is proved.

Similarly, if $10t + u$ does not contain the factor $10n + 1$, $10t + u = p(10n + 1) + r$, where r represents the remainder. From this, by simple algebra, we arrive at the conclusion that in such a case $t - nu$ cannot contain $10n + 1$ as a factor.

The converse of Theorem 1 is also true. This may be shown in the following manner. By supposition,
$t - nu = k(10n + 1)$, where k is integral. Then,
$10t - 10nu + u = 10k(10n + 1) + u$; or
$10t + u = (10k + u)\ (10n + 1)$. Hence $10t + u$ contains the factor $10n + 1$.

Evidently this theorem may be applied to each succeeding remainder, $t - nu$, one digit being deleted at each stage of the process. Thus the remainder gradually becomes smaller and must eventually reduce to 0, if our original number contained the factor $10n + 1$. It should be

noted that no assumption has been made that the factor $10n + 1$ is prime; hence, the theorem is applicable to any factor ending in digit 1.

As an example of the application of the rule consider the number: $481709 = 31\ (15539) = 31\ (41)\ (379)$. If we were unaware of the factors of the given number we should start testing for divisibility by 31 for the reason that it is the smallest prime ending in digit 1 for which we need to make trial under the theorem. Here $n = 3$, and the process is as follows:

$$
\begin{array}{r}
481709 \\
\quad 27 \\
\hline
48143 \\
\quad 9 \\
\hline
4805 \\
\quad 15 \\
\hline
465 \\
15 \\
\hline
31 \\
3 \\
\hline
0
\end{array}
$$

According to the theorem the first remainder, 48143, is divisible by 31 if the original number is divisible by 31. The same is true of the remainders 4805 and 465. Finally there is no remainder, so 481709 contains 31 as a factor.

It should be noticed that the process may be shortened by bringing down the digits from above only as they are needed, and by omitting the last step in the process.

It is with the quotient that we are next concerned. Inspection shows that this always consists of the series of units digits in reverse order. That is, 15539 is the quotient. The reason for this rule becomes evident when the process in the example is written out in full, and the arrangement is precisely similar for any number and for any factor of the form $10n + 1$. Thus:

$$
\begin{array}{l}
481709 \\
\quad 279 = 9\ (31) \\
\hline
481430 \\
\quad 930 = 3\ (31)\ (10) \\
\hline
480500 \\
\quad 15500 = 5\ (31)\ (100) \\
\hline
465000 \\
155000 = 5\ (31)\ (1000) \\
\hline
310000 = 1\ (31)\ (10000)
\end{array}
$$

This quotient, 15539, should be tested again for the factor 31. This failing, 41 is the next factor to be tried. Here $n = 4$, and the shortened process is as follows:

Hence, 15539 is divisible by 41, the quotient being 379, which is prime. Thus, the factors of 481709 are 31, 41, and 379.

$$\begin{array}{r} 15539 \\ 36 \\ \hline 517 \\ 28 \\ \hline 123 \end{array}$$

If the original number had contained a greater number of digits, we should have gone on testing for divisibility by 61, 71, etc., under the same rule.

Next, let $10n + 9$ represent any number of two or more digits which ends in the digit 9, n being any positive integer. Defining the symbols as before we have the following theorem:

THEOREM 2. *If any number* $10t + u$ *is divisible by* $10n + 9$, *then the number* $t + (n + 1)u$ *is also divisible by* $10n + 9$.

In this case we have by assumption,
$10t + u = p(10n + 9)$, where p is integral. Then,
$10t(n + 1) + (n + 1)u + t = p(n + 1)\ (10n + 9) + t$; or
$t + (n + 1)u = [p(n + 1) - t]\ (10n + 9)$.

Now, since $p(n + 1) - t$ is integral, it follows that the expression $t + (n + 1)u$ contains the factor $10n + 9$. Also, in this case, since $t + (n + 1)u$ is always positive the process will never reduce to zero under the repetitions of the rule, as in the case of numbers ending in digit 1. However, if the process is continued, since a digit is deleted at each stage of the process, the remainder must finally reduce to the stage where it becomes
$10t + u = d(10n + 9)$, d being a single digit. But,
$d(10n + 9) = 10nd + 9d = 10nd + 10a + b$, since $9d = 10a + b$, where a and b are digits and a may be 0. Hence,
$10t + u = 10(nd + a) + b$. Thus, $t = nd + a$, and $b = u$. Also, $9d = 10a + u$. Then, reducing one stage lower by the process of Theorem 2, we have:
$t + (n + 1)u = (nd + a) + (n + 1)\ (9d - 10a) = (10n + 9)\ (d - a)$.

But, since $9d = 10a + u$, all the symbols being digits, it follows that $d - a$ must always be 1. Therefore, the final remainder, $t + (n + 1)u$, invariably is the factor $10n + 9$ itself, if the original number, $10t + u$, contains that factor.

Now, the negative of Theorem 2 and also its conjugate may be proved very readily by the method employed under Theorem 1, so the process need not be repeated. We may proceed, then, to a consideration of an example of the use of the theorem.

Let us select the number, $1422131 = 19\ (29)\ (29)\ (89)$. If we had no knowledge of the factors of the given number, we should first

run through the tests for factors ending in digit 1. These failing, we next should test for divisibility by 19. In this case we have $n = 1$, and $n + 1 = 2$, the test number. The process follows.

$$\begin{array}{r} 142213\underline{1} \\ \underline{\quad 2} \\ 21\underline{5} \\ \underline{\quad 10} \\ 3\underline{1} \\ \underline{\quad 2} \\ 4\underline{2}\underline{5} \\ \underline{\quad 10} \\ 1\underline{5}\underline{2} \\ \underline{\quad 4} \\ 1\underline{9} \end{array}$$

It is seen that the remainder reduces to 19, and so the original number contains the factor 19. Next, we must derive the rule for the quotient. Starting with the final remainder, $10n + 9$, let the subscripts 1, 2, 3, etc., refer to the successive remainders in reverse order. Then,

$t_1 + (n + 1)u_1 = 10n + 9$, and $10t_1 + u_1 = (10n + 9)\ (10 - u_1)$. Also, $t_2 + (n + 1)u_2 = (10n + 9)\ (10 - u_1)$; and $10t_2 + u_2 = 10(10n + 9)(10 - u_1) - 10(n + 1)u_2 + u_2 = (10n + 9)\ (100 - 10u_1 - u_2)$... Similarly, $10t_3 + u_3 = (10n + 9)\ [1000 - (100u_1 + 10u_2 + u_3)\ ]$.

This gives rise to the following rule for finding the quotient under the process of Theorem 2. Form the number made up of the end digits arising in the reduction process, in reverse order. Subtract this from the smallest integral power of 10 which exceeds the number. The remainder is the quotient. Stated more simply, subtract the units digit of this number from 10, and each of the others from 9.

Thus, in the example last shown, the quotient of 1422131 by 19 is 74849. This quotient again should be tested for factor 19. This failing, we should then test for the prime number 29. Here $n = 2$, and $n + 1 = 3$. The process proceed as follows:

$$\begin{array}{r} 7484\underline{9} \\ \underline{\quad 27} \\ 51\underline{1} \\ \underline{\quad 3} \\ 75\underline{4} \\ \underline{\quad 12} \\ 8\underline{7} \\ \underline{\quad 21} \\ 2\underline{9} \end{array}$$

We find that 29 is a factor and that the quotient is 2581. This must be tested again for 29. Using precisely the same rule as before we have:

$$\begin{array}{r} 258\underline{1} \\ \underline{\quad 3} \\ 26\underline{1} \\ \underline{\quad 3} \\ 2\underline{9} \end{array}$$

It is seen that 29 again is a factor, and that the quotient is 89, a prime.

Hence, $1422131 = 19\ (29)\ (29)\ (89)$.

Now, let us consider the case of a factor ending in the digit 7. Such a number may be represented by $10n + 7$, where n is a positive integer. The following theorem is applicable.

THEOREM 3. *If any number* $10t + u$, *where* t *is any positive integer and* u *is the digit in units place, is divisible by* $10n + 7$, *then the number* $t - (3n + 2)$ *is also divisible by* $10n + 7$.

By assumption, $10t + u = p(10n + 7)$. Then,
$(3n + 2)\ (10t + u) + t = p\ (3n + 2)\ (10n + 7) + t$; and
$t - (3n + 2)u = [3t - p(3n + 2)\ ]\ (10n + 7)$.

But, $3t - p(3n + 2)$ is integral. Hence, $t - (3n + 2)u$ is divisible by $10n + 7$.

The negative and the converse of Theorem 3 may easily be shown by a method very similar to the one employed under Theorem 1, so it is unnecessary to show the steps here. However, the determination of the quotient is deserving of attention.

Let u_1 be the last end-digit of the reduction process before arriving at a recognizable multiple of $10n + 7$; and let this multiple be represented by $d(10n + 7)$ where d is a digit. Then, by the theorem,

$t_1 - (3n + 2)u_1 = \mathrm{d}\ (10n + 7)$, and from this we have
$10t_1 + u_1 = (3u_1 + 10d)\ (10n + 7)$. At the next preceding stage of the reduction process we have

$t_2 - (3n + 2)u_2 = (3u_1 + 10d)\ (10n + 7)$; and from this we get $10t_2 + u_2 = (3u_2 + 30u_1 + 100d)\ (10n + 7)$. Thus, at this stage of the process the quotient is $(3u_2 + 30u_1 + 100d)$, and at the next stage it would be $(3u_3 + 30u_2 + 300\ u_1 + 1000d)$, and so on until the original number is reached. This gives rise to the rule for finding the quotient in the reduction process of Theorem 3:

Form a multiplicand from the end-digits of the reduction process in reverse order. Multiply this by 3, and add in the digit d one place to the left of the multiplicand.

To illustrate this let us use the example 142709 and test it for divisibility by 37. Here, $n = 3$, and $3n + 2 = 11$. The remainder finally reduces to 74, which is twice the factor for which we are testing. Hence, $d = 2$. The process is as follows:

142709
99
171
11
1406
66
74 = 2 (37)
44
−37 = −1(37)

When the process is terminated at the remainder 74 we find the multiplicand formed by the end-digits to be 619. Hence, the quotient is found as indicated by the rule, thus:

619
3
1857
$d = 2$
3857

Now, suppose that the process is carried one step further. In this case $d = -1$, and the multiplicand is 4619. The quotient is found in this case to be the same as before.

4619
3
13857
−1
3857

Hence, $142709 = 37\ (3857)$. Here we have illustrated the fact that these processes may be terminated at any remainder, and the quotient found by the same rule. However, it is evident that the process should be carried far enough to enable us to recognize the remainder as a multiple of the factor sought.

A glance at the equations of derivation of the last rule will show that in case the final remainder is 0 the original number is divisible by 3. The number 661929 is an example of this, and it is to be tested for divisibility by 17. The process follows:

661929
45
6147
35
579
45
612
10
51
5
0

Here our multiplicand formed of end-digits is 12979, and the quotient is 3(12979) = 38937. Hence, $661929 = 17(38937)$.

It still remains to derive a rule for testing for factors ending in digit 3. Let $10n + 3$ represent any such number, n being any positive integer.

Then, with our symbols having the same meanings as before, we may prove the following theorem:

THEOREM 4. *If any number,* $10t + u$, *is divisible by* $10n + 3$, *then the number,* $t + (3n + 1)u$, *is also divisible by* $10n + 3$.

By assumption, $10t + u = p(10n + 3)$, where p is integral. So, $(3n + 1)10t + (3n + 1)u + t = p(3n + 1)(10n + 3) + t$. That is, $t + (3n + 1)u = [p(3n + 1) - 3t](10n + 3)$. Hence, since $p(3n + 1) - 3t$ is integral, the number $t + (3n + 1)u$ is divisible by $10n + 3$.

The negative and the converse of this theorem both follow in a simple manner precisely as for Theorem 1 and need not be repeated. However, the final remainder in the process needs to be considered as well as the derivation of the quotient.

By the theorem this final remainder cannot be 0, but must be positive since its form is $t + (3n + 1)u$. It will be assumed that this remainder has been reduced to such a point that it may be recognized as a multiple of $10n + 3$ by a single digit, d. Then, if the end-digits of the process in reverse order are u_1, u_2, u_3, etc., we have the equation, $t_1 + (3n + 1)u_1 = d(10n + 3)$; or,
$10t_1 + u_1 = (10d - 3u_1)(10n + 3)$. And, at the next stage,
$t_2 + (3n + 1)u_2 = (10d - 3u_1)(10n + 3)$; or
$10t_2 + u_2 = (100d - 30u_1 - 3u_2)(10n + 3)$. Likewise,
$10t_3 + u_3 = (1000d - 300u_1 - 30u_2 - 3u_3)(10n + 3)$; etc.

Hence, we have the following rule for deriving the quotient of $10t + u$ by $10n + 3$ under the reduction process of Theorem 4.

Form a multiplicand from the end-digits in the reduction process in reverse order. Multiply this by 3, and subtract the product from the number beginning with digit d and followed by as many ciphers as there are digits in the multiplicand.

Take as an example under Theorem 3 the number $187381 = 23(8147)$. If we were unaware of the factors of this number, we should finally test for 23. Then, n would be 2, and $3n + 1 = 7$. The reduction process would be as follows:

187381	Here, the multiplicand made up of the end-digits is 3951, and $d = 2$, as shown. Hence, the quotient is $20000 - 3(3951) = 8147$.
7	
745	
35	
909	
63	Now, it was remarked under Theorem 1 that no assumption had been made that it applied only to prime numbers. Such a statement applies also to the other three
253	
21	
$46 = 2\ (23)$	

theorems. However, the process of carrying out the first rule is simpler than any of the others; hence, its application to composite factors is of especial importance. We shall now prove the following theorem:

THEOREM 5. *If a composite whole number,* $10t + u$, *containing any factor of* $10n + 1$, *is tested for the factor* $10n + 1$ *(by the process of Theorem* 1), *then, the number* $t - nu$ *will contain every factor of* $10n + 1$ *contained by* $10t + u$.

Let $10n + 1$ have two or more factors, and let any one of these be $10q + r$, where r is the digit 1, 3, 7, or 9; and where the other factor, whether prime or composite, ends in the digit 1, 7, 3, or 9 respectively. Then, $10n + 1 = (10q + r)s$, where s is integral. Now, let $10t + u = m\ (10q + r)$, where m is integral and does not contain $10n + 1$. Then,
$(10t + u)n + t = mn(10q + r) + t$; and
$t - nu = t(10n + 1) - mn(10q + r) = t(10q + r)s - mn(10q + r)$. Or, $t - nu = (st - mn)\ (10q + r)$. Hence, since $st - mn$ is integral, $t - nu$ contains the factor $10q + r$, and the theorem is proved.

Now, $st - mn$ cannot be 0 unless $t = nu$, and that can happen only when $10t + u$ contains $10n + 1$ as a factor, as was shown under Theorem 1. Hence, if $10t + u$ contains any factor of $10n + 1$, but not $10n + 1$ itself, then $t - nu$ must reduce to a remainder that may be recognized as containing that factor.

Let us see how the final quotient, containing no factors of $10n + 1$, may be derived after all the factors of $10n + 1$ contained in $10t + u$ have been recognized at the end of the process and taken out.

If P represents the product of all the factors of $10n + 1$ contained in $10t + u$, and if A is the product of all other factors of $10n + 1$, then, $10n + 1 = PA$. And, at the end of the reduction process, $t - nu = Pb$, where b is integral and not a factor of $10n + 1$. Then, if the subscripts 1, 2, 3, etc., refer to the successive remainders of the process in reverse order, we have: $t_1 - nu_1 = Pb$; $t_2 - nu_2 = 10Pb + 10nu_1 + u_1 = 10Pb + (10n + 1)u_1$. But, $10n + 1 = PA$; hence, $t_2 - nu_2 = P(10b + Au_1)$... Also, $t_3 - nu_3 = 10(t_2 - nu_2) + 10nu_2 + u_2 = 10P(10b + Au_1) + u_2\ (10n + 1) = P\ [100b + A(10u_1 + u_2)]$, etc.

This gives rise to the following rule. When testing for factors under Theorem 5 form a multiplicand of the end-digits in the reduction process in reverse order. Multiply this by that factor, (A), of $10n + 1$ not contained in the last remainder. Add to this product the number formed by that factor in the last remainder not found in $10n + 1$, followed by as many ciphers as there are digits in the multiplicand formed of the end-digits.

Let us take as an example the number $1339195 = 11(13)(9365)$. Suppose that we were unaware of the factors of this number, but wished to test it for the three consecutive primes 7, 11, and 13. Now, the product of these primes is 1001 which is of the form $10n + 1$. Hence, $n = 100$, and the reduction is as follows:

$$
\begin{array}{r}
1339195 \\
\quad 5 \\
\hline
33419 \\
\quad 9 \\
\hline
2441 \\
\quad 1 \\
\hline
1144 = 8\,(11)\,(13) \\
-400 \\
\hline
-286 = -2\,(11)\,(13)
\end{array}
$$

If we should stop at the difference 1144 we readily find its factors to be 8, 11, and 13. Hence, since we are testing for 7, 11, and 13 we conclude that our original number contains the factors 11 and 13, but not 7. The multiplicand formed of the end-digits above the remainder 1144 is 195, and the missing factor is 7. Hence, the quotient when 1339195 is divided by 11(13) is found thus: $7(195) + 8000 = 9365$. When the reduction process is carried one step farther we obtain the remainder $-286 = -2\,(11)\,(13)$. Thus, the quotient is $7(4195) - 20000 = 9365$, the same as before; and $1339195 = 11\,(13)\,(9365) = 5\,(11)\,(13)\,(1873)$.

To resolve numbers into their prime factors under Theorem 5 test-products have been arranged from the prime factors. These products all end in the digit 1 so as to come under the simple process of Theorem 1, and they have been grouped so that the factors shall follow in order of size as nearly as possible in order to resolve smaller numbers with fewer operations. Such an arrangement is Group Ia, which is capable of resolving any number of four digits into its prime fac-

tors, and may succeed with much larger numbers. It is assumed that the given number to be tested has already been factored by the obvious primes 2, 3, and 5.

In groups Ia, I, II, and III each test-product is of the form $10n + 1$, and the test-number is n. In Group Ia, n does not exceed a 3-digit number, so that the tests are especially easy to carry out. In Groups I and II, n does not exceed a 4-digit number, and in Group III a 5-digit number.

Suppose we were testing the number 4709 for prime factors. Since its square-root is less than 70 it certainly is not necessary to employ more than the first nine tests under Group Ia. In fact, although test No. 1 would yield no factor, test No. 2 discovers the factor 17, with the quotient 277 which is seen to be a prime by a glance at Group II. By the process of division it would have been necessary to have made tests for 3, 7, 11, 13, and 17 separately.

The thirty tests in Groups I and II will detect the prime factors of any number with no more than five digits, and for many much larger numbers as well. By division the work of reducing a 5-digit number to prime factors might be very tedious, requiring as many as 64 separate divisions, perhaps.

With numbers of six digits Groups I, II, and III all may have to be used in order to test all numbers as large as the square-root of the number to be resolved. Hence, as many as 84 trials may need to be made, but division would require twice as many. These groups contain all the primes above 5 and below 1000.

GROUP Ia

Test No.	Prime Factors	Test Product
1	7 (11) (13)	100 1
2	17 (23)	39 1
3	19 (29)	55 1
4	37 (43)	159 1
5	31 (41)	127 1
6	47 (53)	249 1
7	59 (79)	466 1
8	61 (71)	433 1
9	67 (73)	489 1
10	9 (89)	80 1
11	83 (97)	805 1

GROUP I

Test No.	Prime Factors	Test Products
1	3 (7) (11) (13) (17)	5105 1
2	19 (29) (31)	1708 1
3	23 (37) (41)	3489 1
4	43 (47)	202 1
5	3 (53) (59)	938 1
6	61 (71)	433 1
7	67 (73)	489 1
8	79 (89)	703 1
9	83 (97)	805 1
10	(101)	10 1

GROUP II

Test No.	Prime Factors	Test Product
11	103 (107)	1102 1
12	109 (139)	1515 1
13	113 (127)	1435 1
14	131 (151)	1978 1
15	137 (163)	2233 1
16	149 (179)	2667 1
17	157 (173)	2716 1
18	167 (223)	3724 1
19	181 (191)	3457 1
20	193 (197)	3802 1

Test No.	Prime Factors	Test Product
21	199 (229)	4557 1
22	211 (241)	5085 1
23	227 (233)	5289 1
24	239 (269)	6429 1
25	251 (271)	6802 1
26	257 (263)	6759 1
27	277 (283)	7839 1
28	281 (311)	8739 1
29	293 (307)	8995 1
30	313 (317)	9922 1

GROUP III

Test No.	Prime Factors		Test Product	
31	331	(401)	13273	1
32	337	(353)	11896	1
33	347	(373)	12943	1
34	349	(359)	12529	1
35	367	(383)	14056	1
36	379	(389)	14743	1
37	397	(433)	17190	1
38	409	(419)	17137	1
39	421	(431)	18145	1
40	439	(449)	19711	1
41	443	(457)	20245	1
42	461	(491)	22635	1
43	463	(487)	22548	1
44	467	(503)	23490	1
45	479	(499)	23902	1
46	509	(569)	28962	1
47	521	(541)	28186	1
48	523	(547)	28608	1
49	557	(563)	31359	1
50	571	(601)	34317	1
51	577	(593)	34216	1
52	587	(613)	35983	1
53	599	(619)	37078	1
54	607	(643)	39030	1
55	617	(653)	40290	1
56	631	(641)	40447	1
57	647	(673)	43543	1
58	659	(709)	46723	1
59	661	(691)	45675	1
60	667	(683)	46239	1
61	701	(751)	52645	1
62	719	(739)	53134	1
63	727	(733)	53289	1
64	743	(757)	56245	1
65	761	(811)	61717	1
66	769	(789)	60674	1
67	773	(787)	60835	1
68	797	(823)	65593	1
69	809	(829)	67066	1
70	821	(881)	72330	1
71	827	(853)	70543	1
72	839	(859)	72070	1
73	857	(863)	73959	1
74	877	(883)	77439	1
75	887	(953)	84531	1
76	907	(983)	89158	1
77	911	(941)	85725	1
78	919	(929)	85375	1
79	3	(937)	281	1
80	3	(947)	284	1
81	3	(967)	290	1
82	971	(991)	96226	1
83	3	(977)	293	1
84	3	(997)	299	1

As an example of the use of these tables let us factor the nine digit number 307949317. For such a large number it is best not to employ the table of test-products under Group Ia, since the rapidity of reduction is not so great as with Group I. So, starting with Test 1, Group I, we have as the test-product 51051, and as the test-number, $n = 5105$. The process of reduction, then, under Theorem 5, is as follows:

307949317 (5105 1)
35735
759196
30630
3045289
45945
258583
15315
10543 = 811 (13)

We cannot reduce the remainder below 10543 by this process, but since 10543 must contain every factor of the group 3, 7, 11, 13, and 17, contained by the original number; and since 51051 also contains these factors, it follows that the difference between any multiple of 10543 and 51051 must contain any of those factors contained by 307949317. Thus, we have the following process:

5(10543) = 52715
51051
16 | 1664
8 | 104
13

In this way it is found that only one of the set of factors, namely, 13, is contained by 10543. Dividing 13 into this remainder we get the quotient 811, as shown above.

Thus, we know that the original number contains the factor 13, and to find how many times it contains it we must resort to the rule for quotient under Theorem 5. Taking the product of the missing factors we have: 3(7) (11) (17) = 3927, and so the quotient is as shown below:

3967 (3927) = 15578409
811 (1000) = 8110000
1st quotient 23688409

Hence, 307949317 = 13 (23688409). But, this quotient must be tested again for divisibility by 13. This may most readily be done by using Test 1, Group Ia. However, this test fails as well as all others, through Group I, until we reach No. 11, in Group II. For this test the test-product is 11021, and the corresponding test-number is $n = 1102$. The reduction is as follows:

23688409 (1102 1)
9918
58922
2204
233688
8816
14552
2204
—749 = —7 (107)

Thus, we find that 23688409 contains the factor 107, but not the factor 103. Hence, 23688409 = 107(221387); and further that 307949317 = 13 (107) (221387). The computation of the last quotient is shown below:

2829
103
291387
—70000
221387 2nd quo.

To test a second time for the factor 107 we might adopt the short test-number 32, since 3(107) = 321. Or, we may continue with the test-number 1102. The latter is convenient since the number to be tested contains six digits. Thus we have:

221387 (1102 1)
7714
14424
4408
—2966 = —2(1483)

Since, 1483 does not contain 107 as a factor, we are certain that 221387 does not contain it. So, we proceed to try the tests from No. 12 onward. These all fail until we reach No. 24. For this the test-product is 64291, and so the test-number is 6429. The process follows:

221387 (6429 1)
45003
—22865 = —85(269)

Obviously the number 22865 is too large to determine by inspection whether it is divisible by 239 or 269. However, we may reduce the problem by subtracting multiples as before. Thus,

—68595
64291
4| 4304
4| 1076
269

In this manner it is decided that 221387 contains the factor 269, but not the factor 239. Next, we divide 269 into 22865 above, and obtain 85. So, to obtain the final

quotient, the end-digit being 7, we proceed thus:

$$\begin{aligned} 7(239) &= 1673 \\ &\quad -850 \\ &\quad \overline{823} \end{aligned}$$

An inspection of Group III shows that 823 is prime. Hence the factors of our original number, 307949317 are: 13, 107, 269, and 823; and, in this case it was unnecessary to proceed to the 68th test under Group III to discover the last factor.

This is a typical case of the procedure in factoring numbers of many digits. Of course it would fail if there had been two factors each larger than 1000. In such an example it would be necssary to form a fourth group of test-products of primes. These products would end in digit 1, and the factors would each be above 1000.

WHAT SCIENCE SHOULD BE TAUGHT CHILDREN OF FLORIDA? METHODS OF INVESTIGATING THIS PROBLEM

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Practically every science teacher working in the schools of Florida must at some time or other stop and reflect regarding the practicality of the subject matter being taught in our state courses of study. The most prominent curriculum makers are now in agreement that the subject matter presented in schools should be adapted to the *needs* and *interests* of the adolescents who are engaged in the learning processes. However, these curriculum experts are disagreed upon just what the needs and interests of the adolescents are.

Will the needs and interests of the individual vary with the local environment? Most assuredly they will! The interests of children living in the mountainous coal mining districts of Pennsylvania are not the same as those of the children who reside in the Everglades of Florida. The science of these regions is very different. Why should the students of these geographically different regions be fed from the same pedagogical spoon?

It is rather trite to say that the adaptation of our science courses of study in Florida to local needs is conspicuously absent. But the meaning becomes nothing short of tragic when one tests the knowledge of the children concerning local scientific material of a most elementary nature. About 25% of the children in the ninth grade of the Groveland school realized the significance of a chemical soil analysis to determine whether the land is acid or alkaline, while only 10% knew that Florida has the most even temperature of any state in the Union.

Our present science textbooks are not very adequate in presenting subject matter which gives the information desired by the pupils. Pollock[1] studied the questions asked by 3500 eighth grade children in Columbus, Ohio, and found that 43% of the questions asked were not discussed or even touched upon in the textbooks. Morris

[1]Pollack, C. A., *Educational Research Bulletin,* Ohio State University, Vol. 3, (Jan. 9, 1924), p. 3ff.

Meister examined fifteen textbooks and compared these with children's questions. He found in these textbooks from 21% to 64% of the subjects occurring on the "Children's Interests List."

Miss Loraine Hunter, in her recent and as yet unpublished dissertation for the doctorate at Peabody College, set up certain criteria in her attempt to evolve "Some Important Biological Problems of the Southeastern Region." She concluded that the five most important problems confronting the eleven southeastern states are: (1) soil conservation, (2) forest depletion and conservation, (3) dietary deficiences, (4) health deficiencies other than of dietary origin, (5) inadequate living conditions. Surely one must agree with Miss Hunter that these problems are of utmost importance to the people of the southeastern region. Yet when an actual check was made of the subject matter contained in the biology textbooks used in the schools of this region which were members of the Southern Association of Secondary Schools and Colleges, less than 0.03% of the total combined textbook space was devoted to these problems of major importance.

Other studies concerning the lack of adjustment of science courses of study to local needs and interests can be cited. When one considers that in America the textbook is as yet central to the learning processes that are carried on in the classroom, the significance of Miss Hunter's study becomes appalling.

The incorporation of local science materials into the Florida curriculum is decidedly more needed than attained. Apparently no one knows the answer to such questions as what science should be taught Florida children, at what grade levels this material should be presented, what adjustment should be made in teaching science to the rural youth, and who should decide upon the materials presented in any local community.

Let us now examine some of the methods by which there may be reached a more thorough understanding of the solution of the problem of what science to teach the children of Florida.

In attempting to arrive at a method of determining "What Science Should Be Taught Children of Florida," one readily realizes that he is approaching a problem which lies deep in the heart of subjectivity. A purely objective investigation of this subject is at the present time an impossibility.

Four methods of approach to this problem seem to present themselves. One is to take a cross section of lay opinion and thus determine public sentiment regarding the matter; another is to study the science articles occurring in representative newspapers of the state; a third method is to determine what the science interests of

the children themselves may be; and the fourth is, through the efforts of a small hand-picked group of experts, to find what science seems best for the Florida citizen to know in order to live a full and happier life.

As pointed out previously, however, the final analysis of each of these methods must of necessity be the result of someone's opinion. For that matter, the validity of anything must ultimately be based on human judgment.

Cross-Section of Lay Opinion—The first method—that is, the selection of a cross-section of public opinion—seems to be the most reliable. If indeed we believe in a democracy, we should not fear the thought of taking our science curriculum directly to the people for their approval. If our lay people can be made to reflect upon this subject, is it not possible that valuable contributions to the solution of this problem may be offered? Is it not probable that the common man may be able to determine what science his child ought to be taught? Does not a parent, after all, have a right to say what courses of study should be offered in the public schools of our land?

There is some authority among curriculum makers to the effect that lay groups may be of value in evolving a newer and more vital course of study. When Dr. Sidney Hall began the work of revising the Virginia State Course of Study, he published an invitation in the leading Virginia newspapers inviting any interested group such as service clubs, civic clubs, P. T. A. organizations, and so on, to join in studying the problem. Hopkins, Caswell and Campbell, and Spears in their books regarding curriculum making mention the value of lay participation. Paul R. Morrow[2] writes of the P. T. A. participation in the new Georgia curriculum program. In a recent bulletin, the Alabama Department of Education points out that lay groups may aid greatly in the improvement and enrichment of the curriculum.[3]

With the objective of taking the problem directly to the people of all walks of life, it may be possible to obtain more than a faint hint as to what science should be taught the Florida children. The author of this paper is now engaged in sampling lay opinion concerning this problem. A check list of 140 items has been constructed. These items are statements, for the most part, which deal with the science materials that are peculiar to Florida. This list covers the general fields of agriculture, health, meteorology, geology, forestry,

[2]Morrow, Paul R., *Curriculum Journal,* Vol. IX (May, 1938), pp. 218-220.

[3]*A Guide to the Improvement of the Curriculum,* Alabama Department of Education Bulletin, 1938, No. 8, pp. 44-45.

wild life, and fishing. People are merely asked to answer these two questions regarding the statements: "Do you know, or are you interested in knowing," and "Should this be taught in our public schools?" This check list does not claim to be anything more than a sample which cuts across several fields of Florida science, but from this study it is hoped that public sentiment may be determined regarding the adaptation of subject matter material in our state. Lawyers, doctors, dentists, merchants, mechanics, farmers, ministers, housewives, state senators, county agents, school teachers, etc., from all parts of the state will be given a chance to help in studying our science curriculum. It is hoped that at least 2000 individuals may be questioned in this manner.

Newspaper Clippings As An Index to Science Interests—A second method suggested as a means of approaching the problem of a more adequate science curriculum involves the use of Florida newspapers and assumes that the editors know what will interest their public. This procedure of studying newspaper clippings has been used in several investigations determining public interest.

The author is investigating at present the science articles which are occurring in representative Florida newspapers. Five daily newspapers from as many sections of the state are being critically examined over a period of six months in order to determine in what science the editors consider their subscribers most interested. These clippings are being sorted and a close observation is being made to see if the science items for each of the sections differ, and if so, in what respect. It also may be possible to determine by this procedure the science about which the subscribers like most to read.

Science Interests of Children—The science interests of children are by no means easily determined. Such investigators as Curtis, Pollack, Dowling, Craig, and Webb have used various methods to determine the science in which children are mainly interested.

Slavson and Speer[4] list several methods of investigating children's science environment—the "science hunt game," the questionnaire method, magazine department question-and-answer method, the object-question method, and the spontaneous-question technique.

These authors conclude their discussions of these so-called objective methods by seriously questioning the validity of each. Francis D. Curtis, who has analyzed scores of studies in science education, points

[4]Slavson, S. R., and R. K. Speer, *Science in the New Education* (New York: Prentice-Hall, 1934), pp. 54-86.

out that no one knows what is the best subject matter to teach children of any given age. Children are so irresponsible and are so much interested in problems of immediate concern that their scientific interests cannot be determined with a high degree of validity. It is rather doubtful if the children themselves know what science interests them most. Slavson and Speer further point out that children's responses to questions are to a great extent a result of previous conditioning. Again, children frequently refrain from asking many questions because of fears established by adults' taboos, secrecy, and prohibitions.[5]

The techniques and methods now being used to determine children's scientific interests are, at best, quite inadequate. It would seem that both the cross-section of lay opinion and the newspaper clipping method offer a more valid and reliable approach to the problem of determining the scientific interests and needs of children.

Curriculum Making by Experts—For many years curricula have been devised by a handful of supposed experts who weighed their decisions more or less carefully and then handed down courses of study to teachers and students. This is approximately the same technique that is used by the doctor in treating his ailing patients. The doctor studies the symptoms, diagnoses the case, and prescribes the remedy or treatment to be followed. The skilled curriculum makers may well ask, "Do we not know far more about the subject matter to be taught than those who have never seriously considered the problem?" The point is well taken, but there are other factors which should be held in mind. Curtis[6] has most excellently said, "Nobody *knows* whether the present generally accepted selection of materials for . . . . . science is best."

It must stand to reason, however, that a group of people such as the members of the Florida Academy of Sciences, if interested and enthusiastic, could arrive at a more valid and appropriate science curriculum than the one now in effect.

The solution of the problem of selecting and adapting the science curriculum to the needs and interests of Florida children will eventually be solved. At the present time, however, it is almost a case of the "blind leading the blind." Much study must be done, and many investigations must be followed up before a valid conclusion to this

[5]*Op. cit.*, p. 86.

[6]*A Synthesis and Evaluation of Subject Matter Topics in General Science* (Boston: Ginn and Co., 1929), pp. 11-12.

problem is reached. At present we can only hope for a preliminary investigation which may perhaps point out the trail to be blazed. The Florida Academy of Sciences should interest itself in the problem, "What Science Should Be Taught in the Public Schools of Florida," and should be the vanguard in the army which conquers the ignorance now enshrouding one of the most pertinent problems of our state.

THE MONARCH BUTTERFLY (DANAUS MENIPPE HUB.) IN FLORIDA

H. T. Fernald
Winter Park

Mass migration of the Monarch butterfuly southward in the fall in enormous numbers has been observed for more than fifty years. Beginning in August in southern Canada, the flight moves south through the United States. It is particularly noticeable along the Atlantic sea coast, where the butterflies seem to keep close to the beach, thousands streaming by while a hundred yards inland they are entirely absent. As the flights pass through successive regions on their way south, the butterflies of these regions either join the migrants (the most plausible hypothesis), or themselves form migrating swarms. The butterflies appear to reach northern Florida the last of October or early in November, and by the tenth of November have arrived in central Florida, the exact time varying somewhat from year to year. By mid-November the mass migration has come to an end, and the butterflies are seen singly on the East Coast and along the middle of the peninsula. On the Gulf Coast, however, there are several records of the butterflies remaining together in swarms, at least for a time.

When the butterflies arrive in Florida they often have torn wings and are much faded. This would seem to indicate that during their flight south they had encountered bad weather. Sometimes, though, they are perfect and of their normal bright color, suggesting a good trip south. That some are battered while others are fresh may be explained by supposing that the battered ones had met with bad weather, and that afterward they had been joined by fresher individuals farther south.

During December and January the butterflies are frequently seen visiting the blossoms of various plants in central Florida; but it is certain that some of them go farther south in the state, since they have been reported from the Everglades; it is probable that they may go as far as Key West and even possibly to Cuba.

About the first of February the insects become very scarce, and before the end of the month they seem to have disappeared. By the last of March or the first of April, however, they normally reappear, and are now fresh in color and perfect in every way. These

individuals do not remain long in Florida, soon disappearing; the presumption is that they have started on their spring journey north. As no mass flights in this direction are known (except, perhaps, one case reported from California), it is probable that in this journey they go singly.

It seems impossible that these fresh spring migrants are the same individuals that come south in the fall; but no evidence of the breeding of the species in Florida during the winter was found until 1937. On January 16 of that year Mr. M. J. Westfall of Orlando showed me some caterpillars about an inch long, some eggs, and four chrysalids taken from a milkweed (probably *Asclepias curassavica*) growing at his home. A visit there showed that more of the eggs and caterpillars were present. They agreed in all of their markings with the early stages of the Monarch, but since these closely resemble and might be mistaken for those of *Danaus berenice* Cram., common in central Florida, the insects were raised to the adult stage. Upon their emergence, on and around January 25, they proved unquestionably to be the Monarch.

The emergence of these insects on January 25 would seem to indicate that the fresh, adult Monarch butterflies should be seen here by the last of January or the first of February, while in fact it is very exceptional to find them so early. A possible explanation of the early emergence of the individuals reared in 1937 may be found in the exceptional warmth of the winter of 1936-37; following that winter many orange trees were in full bloom by January 20, as were also numerous other plants which usually bloom six to eight weeks later. The unusually warm weather may have had an effect on the butterflies, inducing them to begin breeding earlier than is generally the case.

Little is known of the northward flight in the spring. Apparently a few individuals remain in Florida during the summer, as there are scattered reports that they have been seen then; but it is certain that most of the butterflies go north. What happens during this journey is uncertain. Thus, it is not known whether the butterflies that leave the south are the same individuals that eventually reach the northern states and Canada. It is possible that the migrants may move northward for a certain distance, halt and lay eggs for another generation, resume their flight and again lay eggs farther north; or they may migrate for a certain distance, there lay their eggs and die, and the new generation reared from those eggs may be the ones which complete the northward journey. The second hypothesis seems least likely, since they are recorded as reach-

ing Chicago early in June and Massachusetts before the end of that month, and the time necessary for the production of another generation would delay their arrival past these dates. It seems more probable that as they go, some of them stop and repopulate localities all the way from Florida to Canada.

More knowledge of the migratory habits of the Monarch is needed. Questions which need to be answered are many. Among them are: (1) How far south in Florida do the butterflies go? (2) When and where do they usually breed during the winter? (3) Do they ever go north in groups? (4) Are there any deviations from the apparently normal habits outlined here? Answers to these and other problems connected with this butterfly can be found only through observations made by persons in all parts of Florida who will watch for these insects and note what they do.

COOPERATION OF WORK PROJECTS ADMINISTRATION WITH UNIVERSITY AND COLLEGE RESEARCH PROGRAMS

MILTON C. FORSTER
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I am most grateful for the privilege of participating in your annual meetings and of presenting to you a very abbreviated sketch of the manner in which the Work Projects Administration has cooperated in facilitating the research programs of various colleges and universities throughout the country.

The miles of public roads, sewers, and other public utilities, the number of school and public buildings, as well as airports, parks, and playgrounds constructed or improved, is fairly generally known. So, too, are the activities in the cultural fields of the arts, education and recreation. However, considerably less is generally known concerning the many research projects and particularly those directed by the faculties of various universities and colleges. From these research projects have grown several thousand scientific and scholarly articles and books, and it is this part of the program that I should like to discuss with you in a little more detail.

Early studies of the relief rolls revealed the presence of substantial numbers of white collar workers. Two or three percent of the total had had some kind of technical or professional training which fitted them for research work and many others had had a general background of clerical training and experience. In the early years of the depression, no work relief program for this group was undertaken. From 1929 to 1933 professional societies and guilds, teachers' associations, leagues, and other private organizations made desperate but increasingly hopeless efforts to provide work and financial aid for destitute members. The early public works program was generally limited to work on roads and parks for men, and work in sewing rooms for women. However, many of these unemployed white collar workers had had specialized and, in some cases, extensive training, in large part at public expense; and the waste of this training through unemployment and impairment of skill by disuse and discouragement was imminent. By a special allocation of funds, the Civil Works Administration, in 1933, undertook to provide employment for white collar workers on socially useful projects. Public records were rehabilitated, catalogued, and indexed; and modern record systems were installed or otherwise

made more useful and accessible. A few research enterprises were undertaken, mainly under the guidance of other federal agencies that were somewhat accustomed to large-scale enterprises. However, initiating projects in this field was not a simple task and it was imperative to put people to work as quickly as possible.

Research, in contrast to small construction projects, cannot be based upon quickly drawn plans. Research workers throughout the country had few plans for mass employment on hand and had had little experience in designing or operating large-scale undertakings. Scientific and scholarly investigation on a mass basis was a new adventure—almost an uncharted course, as most investigations, because of limited funds, had been carried out in all detail by professionally trained personnel.

Although the inherent difficulties involved were recognized, it seemed imperative to utilize the personnel available in investigating some of the many unexplored research fields and therefore adequately conceived and supervised research projects were encouraged.

As a result, projects for research in the social and natural sciences have been a part of all federal work programs, and although WPA research projects in universities and colleges were rather slow in getting under way, they have progressed with an achievement that is startling. A partial index to completed research projects published in March 1938 lists abstracts and titles of over 2500 publications and reports, of which about one sixth were sponsored by colleges and universities. In this listing, one is impressed by the range of research to which assistance has been rendered through project workers. But, in this connection, I should like to make one point very clear. The Work Projects Administration does not pretend to assume credit for this research. The credit goes where it rightly belongs—to the institution and to the university or college faculty member whose training, ingenuity, and labor made the project possible and the results a fact. WPA is proud to have been of assistance and is proud of the workers who have been employed at tasks which have enabled them to maintain and develop their skills, to rehabilitate themselves in many ways, at the same time making substantial contributions to human knowledge.

During the 1938 fiscal year, research projects sponsored by institutions of higher education which were approved for operation called for an expenditure of over $12,000,000. From July 1 through October 26 of this current fiscal year, projects calling for an expenditure of about $5,000,000 have been approved for operation. These figures do not include studies sponsored by other public agencies that are directed

by college and university faculty members, or studies in the design and operation of which such individuals participated actively through consultative services, but they do indicate roughly the amount of assistance being rendered.

These projects are of three types. The first consists of highly technical jobs under the immediate supervision of staff members where the WPA worker with technical research training works according to ordinary methods of scholarship. The second consists of undertakings on which mere assistance—additional hands—is supplied to scientific personnel in order that they may better utilize their time. The third class consists of researches that can be adapted to the factory process involving the mass use of clerical labor. Naturally, individuals of highly technical training are not very numerous on our rolls, and the major type of assistance rendered falls under classes two and three mentioned above wherein the workers perform accurately certain definite operations on certain specific materials, but do not have the background or training to select or evaluate these materials, functions that are intrinsic to the craftsmanship of the scholar.

The simplest type of project is that in which clerical or laboratory assistance is given to tabulate, to index, or to process materials in a routine manner, relieving the technical personnel of these routine functions. However, many enterprises formerly executed solely by professionally trained personnel have been re-designed into simple, self-checking operating steps so that they may be executed by non-technical personnel. I feel one of the outstanding examples of this contribution to American research is a New York City project sponsored by the National Bureau of Standards for the computation of mathematical tables. Heretofore such tables were patiently ground out by trained personnel or, if a limited number of values were needed, the individual scientist secured the values by computing from the formula. However, under the direction of the National Bureau of Standards and other professional advisors, procedures were evolved by means of which the bulk of the manual work could be executed by WPA white collar clerical workers under competent direction. Some of the tables completed and contemplated are as follows:

1) The first ten powers of the integers from 1 to 1,000.
2) Natural logarithms of decimal numbers from 0.0000 to 10.0000 and of integers from 0 to 100,000 to 16 places of decimals.
3) Probability integrands and integrals to 15 decimal places for arguments between 0 and 1 at intervals of .0001, for arguments between 1 and 3 at intervals of .001, and for arguments between 3 and 6 at intervals of .01.

4) Tangents and co-tangents for the arguments between 0 and 2.0000 at intervals of .0001.

5) Bessel functions for complex arguments.

Other similar projects could be mentioned in which exceedingly technical work has been designed by the scholar to be executed by relatively untrained personnel on a mass production basis with automatic checks introduced at each level of operation to insure accuracy. Much work has been done in designing research for this level of execution by our present available manpower but there are many more research frontiers to be opened, both in the sense of original research fields and in developing and refining research tools of the type mentioned above and on the order of basic sources of social data such as governmental records for economists, sociologists, historians, etc. If research work can be properly designed for this available labor, Dr. Robert C. Binkley of Western Reserve University suggests: "The amount of money devoted to the cultural part of the relief program is so substantial that it should, if properly used, date an epoch in American development."[1]

There are few fields of knowledge in which WPA projects have not been of assistance to university investigators throughout the country. Valuable data on losses and discharges of water resources, soil erosion, and probability of floods have been compiled at New York University. Experiments have been made at the University of North Dakota in heating residences and commercial plants with lignite, one of the State's large natural resources. The University of Oklahoma undertook a systematic study of the performance of meters used with viscous or sticky fluids in order to fill a gap in our knowledge of meter coefficients. The University of Mississippi undertook a comprehensive study of all potentially valuable clay and other mineral substances in Winston County, Mississippi. Reports of this and a number of other studies which I shall mention are on display in the exhibit room.

At Fordham University, studies were conducted on the application of salts of complex cations to the microscopic detection of anions. Under a University of Minnesota project, a method was developed for studying fat transport and phosphorglation spectrophotometrically. An important investigation in the field of medical diagnosis is the study of the acid-insoluble mineral residue in the sputa of silicotics made at the Cornell University Medical College. In the field of biological chemistry, a study of the synthesis and destruction of Vitamin B_1

[1]Binkley, Robert C., "A Specifically American Experiment," *Journal of Adult Education,* Vol. XI, No. 4 (October, 1939), pp. 396-401.

by phycomyces was made at the California Institute of Technology. Assistance was given to a University of Minnesota study of the use of quinidine in the treatment of cardiac irregularities and at the University of California in determining average values for basal respiratory functions in adolescents and adults.

At the Universities of Iowa, Ohio, and California, project workers assisted in constructing cyclotrons and at the University of Minnesota an electrostatic atom smasher, in order further to implement atomic research. In the exhibit room, you may have noticed the Massachusetts Institute of Technology's publication of Wave Length Tables. This work, compiled and prepared with the assistance of protect workers, gives to research men precise wave length tables—a handbook on over 100,000 spectrum lines most strongly emitted by atomic elements under normal conditions of excitation between 10,000 and 2,000 Ångstrom units. For the identification of spectral lines, these tables surpass all other published material as they contain five times as many lines and give new wave-length and intensity data. Other similar studies might be mentioned in the fields of zoology, botany, engineering, etc.

Project workers are assisting archaeologists, anthropologists, and paleontologists. Faculty members of the Universities of Kentucky, South Dakota, Wyoming, Texas, Oklahoma, and other institutions are directing archaeological excavations and laboratory work in the study of early man on this continent. In Texas and Oklahoma, we are beginning to receive clues as to the identity of the people who inhabited that region even before the Indian tribes found in possession of it by the Spanish explorers and early pioneers. Workers are assisting the archaeologists in excavating, in restoring and preserving materials recovered, in cataloguing, classifying, indexing, typing, drafting, freehand sketching, and in bibliographic research.

Problems connected with agriculture and land have been studied in many states, particularly those in which agriculture is an important industry. Over 2,000,000 acres of land were classified as to type and use as well as tenure in California through a project sponsored by the State University. Extended soil reconnaissance studies are also being conducted by the State Agricultural College in Montana. A statewide survey of real property assessments in Montana showed serious inequalities; the ratio of assessed values to sale values on 5,000 farms ranged from 0.1 to 25.0. A project at Iowa State College analyzed agricultural statistics gathered by assessors and demonstrated that considerable variation in farm and livestock production existed within a homogeneous type of farming area and that these variations were related to such factors as quality of soil, size of farm, and tenure of

operator. A study of operating costs, production, income, and marketing among Minnesota creameries was undertaken in cooperation with the State University. Local hog marketing practices in Iowa were investigated by the State College. The South Carolina College of Agriculture is now conducting a detailed survey of rural housing. Rural population mobility has been a subject of concern in many of the western states and at the College of Agriculture, a survey of seasonal labor on irrigated farms in Arizona was conducted. The University of Alabama, with assistance of project workers, prepared estimates of income received by farm and non-farm population in the various counties of the state for 1929 and 1935. At Ohio State University, data were compiled to show the relative position of Ohio among the leading states as to value of industrial production, establishments, wage earners, retail sales, wholesale trade, and other factors. The University of North Carolina is now assisting in a comprehensive survey of local governmental units throughout the state.

Many sociological studies have been concerned with population, crime, delinquency, and other social problems.

Assistance has been rendered to historians, linguists, and to the field of literature through assembling information, preparing bibliographies, and rendering clerical assistance. One of the most important phases of work in this field is the collecting and systematizing of historical documents and the preparation of indexes, bibliographies, and union catalogues.

Psychological and developmental studies have been facilitated. At Yale University, data from the Harvard Growth Studies were analyzed from the point of view of individual growth increments by sub-groups which were homogeneous with respect to factors affecting growth. This longitudinal study of the physical and mental growth of girls and boys aged 6 to 19 involved thousands of tabulations and computations. Staff members of the University of Washington are now directing a statewide mental ability and achievement testing program in the public schools of the state. At other institutions, assistance has been given to appraisals of college guidance services and to other types of administrative investigations which are designed for and can be facilitated by WPA project workers.

A unique enterprise in university research was undertaken by the United States Office of Education through a special allocation of funds from the WPA. This project was a singular and significant innovation in cooperative research among 60 institutions in 32 states, the District of Columbia, and Hawaii. Each institution was invited to participate in all of the studies that it was in a position to undertake. Of 40 studies undertaken, 23 were proposed by the Office of Edu-

cation and 17 by the institutions. From 1 to 14 such studies were conducted in each institution on a comparable basis, resulting in a total of more than 150 separate study reports. One of these reports —College Student Mortality—which is in the exhibit, may be of interest to some of you.

As indicated above, these projects that I have mentioned constitute only a small cross section of the program. A complete summary of the projects, all of which are available for use by researchers, would require many pages even on the basis of the briefest possible treatment. All of them are sponsored or co-sponsored by academic institutions whose facilities supply the technical supervision; in fact, the WPA workers merely assist the scientists in their research. In this way, the highest professional level of work is maintained since the sponsoring institution assumes the responsibility for the technical competence of the work and the interpretation of the results. This type of cooperation that has been evolved with universities and colleges throughout the country in the practical development of plans for improvements to their facilities is the very cornerstone on which the WPA Program is built.

Frequently, when research is discussed, one of the first topics is money resources. European scholars visiting this country are usually impressed by the lack of research assistants provided for the university staff, as in European laboratories it is not uncommon for staff members to have the services of three or more assistants. In America, research workers are expected to do large amounts of routine and semi-routine labor that could be done by less skilled persons and thus free the research men for other and more creative or productive work. Furthermore, when budgetary reductions are made, it frequently happens that the first items to be cut are research funds. In 1938, the National Resources Committee estimated that about $50,000,000 was being expended annually on research by American universities and colleges. This sum is not solely direct expenditures, but includes proportionate allocation of staff time devoted to research and proportionate allocation of library, general administration, and other operating costs of the plant facilities that are used for research purposes. These resources can be and have been expanded by WPA assistance. After using relief workers in research work for two years, the University of California, for example, reported that through WPA assistance a number of research programs had been advanced at least ten years over the stage of accomplishment which would have been possible under ordinary circumstances.

WPA personnel has, as suggested above, facilitated the research programs in colleges and universities and is available in so far as its

resources permit to assist further in intensifying or widening the scope of research investigations. We are constantly seeking to employ our personnel to the best of their capacity, under adequately trained direction and to the best interests of the public and the state and community in which they are located. For research workers or institutions where assistance is a luxury, there is an opportunity to use the manpower that the Federal Government can provide and to push forward some of our many frontiers of knowledge. Mrs. Florence Kerr, Assistant Commissioner in charge of Professional and Service Projects, is greatly interested in studies and undertakings of this nature and Mr. Albert of our Florida State Office, who follows me, will, I believe, discuss with you the mechanics and sponsorship of WPA projects.

May I say once more that I am happy to have had this opportunity to meet with you? The Work Projects Administration is grateful for the privilege of participating, and if there are any ways in which we can be of special assistance to you, our State and Washington offices will welcome your inquiries.

MECHANICS AND SPONSORSHIP OF W.P.A. PROJECTS

Franklin E. Albert
Work Projects Administration of Florida, Jacksonville

The paper that has just been given by Dr. Forster has clearly indicated the many research activities that have been undertaken with the assistance of the Work Projects Administration. The question that arises is how can the research work of Florida scientists be aided by the WPA program. To answer this question it is necessary that I bring to your attention some of the basic requirements and regulations pertaining to the operation of WPA projects.

The WPA is a federal agency which cooperates with states, counties, cities, towns and with various other public agencies, departments and institutions in carrying out needed public improvements and services. This program is designed to provide work and wages for the unemployed. The persons that are certified for WPA employment are assigned to projects.

You may ask how is a WPA project sponsored? The sponsor of a project is required to be a state, municipal or other governmental agency which proposes that the WPA assist it in carrying out a public improvement or public service. A WPA form known as a Project Proposal (WPA Form 301) is prepared by the sponsor along with a plan or documentation indicating the procedures to be used in performing the proposed work. The instructions on the reverse side of the proposal clearly indicate the information desired.

Assistance in the preparation of a proposal and an opinion as to eligibility of the project can be obtained by contacting the Area Offices of the WPA Professional and Service Division or by communicating or calling at the State Headquarters of the WPA at 49 W. Duval Street, Jacksonville. The Professional and Service Division maintains Area Offices in the following Communities: Miami, Orlando, Tampa, Jacksonville, Madison and Pensacola. If in doubt as to the office which services your community, write to our State Headquarters at Jacksonville and you will be placed in touch with the proper office.

When the proposal and documentation have been completed, the Area Office of the Professional and Service Division forwards the material to the State Office for review. The proposal is checked for adequacy as to plan of operation and also for compliance with

WPA eligibility requirements. The proposal is approved, disapproved or amended. If approved it is forwarded by the State Administrator to the Washington Office of the WPA for review and Presidential approval. After the project has been approved in Washington, the State Administrator is authorized to place the project in operation.

I should like to direct your attention briefly to the term "sponsorship" or "sponsor's contribution" as it relates to WPA projects. Since the WPA must use its funds largely for wages, the sponsor must agree to provide most of the materials and equipment necessary for the successful operation of the project. The technical supervision of the project is also the responsibility of the sponsor. The value of these services as well as the price or rental value of the materials and equipment used by or incorporated into the project are termed sponsorship or sponsor's contributions. Where projects involve the collection, tabulation or compilation of material intended for publication and are so described in the project proposal, publication costs financed by the sponsor (including mimeographing, microfilming and other forms of duplication) may be credited as a contribution. Credit may also be allowed for the actual cost to the sponsor of certain transportation and handling charges.

You will in all probability want to know where the WPA has available persons who are qualified to assist in carrying out the researches in which you are interested. We have a considerable number of white collar persons of various occupational skills available in Miami, Jacksonville and Tampa. We also have a number of capable persons available in Orlando, St. Petersburg, Lakeland, DeLand, Tallahassee, Pensacola, Gainesville, Lake City and Key West. I am assured by our Division of Employment that they will make every effort to be of the utmost assistance in obtaining from their roster those persons who are best qualified to aid in the successful prosecution of such studies as qualified sponsors may wish to undertake in various research fields.

I should like to have it clearly understood, however, that the WPA makes available only those workers who have been certified to it for employment; consequently it is not possible for this agency to hire laboratory assistants that you may now have or that you know of, who have not been certified to the WPA. This would defeat the prime purpose of the organization, which as previously stated, is to provide work and wages for the unemployed.

In closing I should like to suggest that you undertake as expeditiously as possible the planning and preparation of project pro-

posals covering the particular studies or researches that are considered to be of public interest and value in line with the conditions that I have outlined.

Since your Academy represents the faculties of all institutions of higher learning in our state I am sure that you will not face any difficulty in obtaining qualified sponsors for your projects.

I wish to assure you that the Professional and Service Division Staff of the state office and the several field offices will be pleased to cooperate with the Florida Academy of Sciences in any way that will be considered desirable and feasible to further scientific research in the state of Florida.

THE FUTURE OF FLORIDA ARCHEOLOGICAL RESEARCH[1]

Sidney A. Stubbs
Florida Geological Survey

The State of Florida contains a vast wealth of pre-Columbian and post-Columbian Indian burial mounds and kitchen middens. The amount of archeological information that these mounds have held is beyond calculation. I say "have held," because for years the contents of these mounds have been and are still being removed by curious citizens and commercial dealers in Indian relics. This has occurred to such an extent that if such promiscuous digging is allowed to continue, the ancient history of our state will be entirely obliterated and that chapter will be lost forever.

Mary J. Atkinson in her book, *The Texas Indians,* calls the Gulf of Mexico the Mediterranean of the western world. Many think of Florida as the connecting link between North America and the West Indies, Central and South America. We hear frequent reports of "Aztec" and "Mayan" artifacts being taken from Florida mounds. Whether or not such reports have a sound basis is difficult to say. Usually before such articles reach a competent investigator (if they ever do), they have changed hands many times and the surviving data are many times second hand and very undependable. One thing we do know, however, is that a continuous stream of trade existed between the races living in Florida and those farther north in Georgia and Alabama. Because of the close proximity of Cuba, it is reasonable to believe that trade may have flourished between the Indians of southern Florida and those of Cuba. We also know that vanquished races from the north moved southward into Florida as a refuge. As these people moved in, they either mingled with the nations already here or drove them into new territory. We have, therefore, an extremely complex and confusing archeological history to unravel. The only means we have of learning of these past events is from a study of artifacts contained in the burial mounds.

The earliest investigation known that approaches the study of Florida mounds with anything like scientific accuracy is that of Clarence B. Moore of the Philadelphia Academy of Sciences. The

[1]Report of the Conservation Committee.

report of Moore's first studies is published in the *Journal of the Philadelphia Academy of Sciences* for 1894. Twenty-eight sites along the St. Johns River south of Palatka are discussed. Moore's studies were continued in Florida and other southeastern states for many years. The results were published by the Philadelphia Academy from time to time and those papers constitute some of the most valuable references that we have on the archeology of the Southern states. More recently the Bureau of Ethnology and other scientific institutions have dug Florida mounds. All of this work, however, has been very limited and cursory in character. By far the greatest part of our mound excavation has been done by unguided individuals and commercial vandals. All the useful data of such digging is forever lost to the scientific world.

Mr. Clarence Simpson, of the State Geological Department, has furnished some interesting figures as to the number of mounds in Florida. While supervising a W. P. A. project for the State Archeological Survey in Hillsborough county, he located and mapped sixty-five mound sites. From Mr. Montague Tallant, a local collector at Manatee, Florida, he obtained a map showing the position of eighty-five mounds in Manatee County. Using these figures as a basis, Mr. Simpson has estimated that there are probably five thousand mounds in the state. Such a large number would seem to indicate that there are plenty of mounds for all and that a little individual digging will do very little harm. Mr. Simpson found, however, that of the one hundred and fifty mounds recorded in Hillsborough and Manatee counties, only one had not been damaged by excavators. The undamaged mound is diligently protected by the owner but even that mound has on some occasions been tampered with by unscrupulous collectors under cover of darkness. It is thus clearly evident that there are very few if any virgin mounds left in the state.

The frequent reports of untouched sites are probably without foundation. A good illustration of this is an experience of the Archeological Survey in Hillsborough County. A site was located near Picnic. The mound was carefully surveyed and an accurate contour map was made. This map showed no irregularities and to all external appearances the mound had hardly been touched by the casual digger. Careful and systematic excavation, however, showed that this mound had literally been dug to the ground time after time. Each worker had just thrown the spoil of his diggings into the hole left by the one who had dug before him, and for that reason as soon as the rains and vegetation had obliterated the traces of the newly filled holes, no one could tell that the holes had ever existed. By questioning older residents of the region, Mr. Simpson

found that the mound had been excavated periodically since before the Civil War.

The commercial excavators, including the treasure hunters, and the curious individuals are the chief offenders in the present destruction of our archeological sites. The commercial collectors and the treasure hunters dig the mounds for personal gain. The treasure hunters often destroy a whole mound searching for gold and silver that may be buried there. They are not particularly concerned with the ceramics and other artifacts, and make little or no effort to preserve them. Of course, if anything odd or unusual is found, it is brought in as a curiosity and preserved until the newness is worn off. Then it is shoved into a corner and forgotten, often finally broken or lost. On the other hand, the objective of the Indian relic dealer is to obtain all the perfect artifacts. Everything else is discarded. Although these men do partially preserve the contents of a mound, the articles become so scattered that it is impossible to reassemble enough of them to be of any value for study purposes and none of the excavation data, which is of vital importance to the scientist, is ever kept. Some of the richest mounds in the state have been destroyed by these commercial vandals.

An outstanding example of the damage that can be done by such collectors is a mound near Cedar Keys. That mound contained an enormous quantity of pottery. It had been partially dug by various people and some very beautiful pieces had been taken out. Some of these became the property of the State Museum at Gainesville and are now on display there. The bulk of the material, however, had not been touched. A few winters ago, a dealer from one of the northern states learned of this mound and began to dig it. Pottery was shipped out by the truck load and now the mound has been completely destroyed. Skeletons, imperfect pots and other unsalable articles were tossed aside. That rich mound has been forever lost to science.

The second general class that is very largely contributing to the ultimate complete destruction of these records of the past inhabitants of our state is even larger than the commercial groups just mentioned. These are the curious but misguided citizens. Into that class fall some of our most worthy organizations and groups, such as the Boy Scouts, the Girl Scouts, many high school and college classes, as well as individual collectors. These people do not intend to be deliberately destructive but the damage that they do is just as great as that done by the commercial excavator. I know of several mounds that have been destroyed by high school, scout and college groups. Their digging is either undirected or mis-directed,

and the mound excavation is really secondary to an afternoon or week-end outing.

It might be well at this point to outline the procedure used by the trained scientist in working a mound, and thus illustrate why it is impossible for the average individual or group of individuals to do such work properly. Mound excavation is a time-consuming and an expensive undertaking. Before a trained worker ever touches a new site, he makes an accurate survey of the mound, determining the exact size and shape. From this information, a detailed contour map is drawn. Wherever possible this map is supplemented by photographs of the mound before it is touched. After this preliminary work has been completed, the site is divided into numbered squares and these squares are excavated separately. As each successive layer of earth is removed, accurate sketches are made of material present and its location. If at all practical these sketches are supplemented by photographs. Each layer of dirt is carefully screened and every article properly numbered, and when necessary treated with preservatives. As each burial is uncovered, the skeleton is sketched and associated artifacts are noted together with the relation these have to the skeleton. If the state of preservation is such that the bones cannot be handled, necessary anthropological measurements are recorded before there is any attempt to move the bones. The type of burial, sex of individual, approximate age, and any pathological characters that may be evident are also noted. Animal and shell remains are recorded as to species and percentage of occurrence. As the work progresses, charts are prepared showing the type and location of the various burials and other pertinent data for each successive level of excavation. The above procedure will of course vary somewhat to meet the peculiar conditions afforded by each site.

From the above outline it is clearly evident that mound excavation is not a simple process. The necessary sketches require the services of a competent draftsman and the photography must be done by an experienced photographer. The notes must be made by a person trained to know what should be recorded and who also has had sufficient experience to be able to see those things. The actual excavation must be done slowly and with much care, otherwise many valuable articles will be lost. Often it takes days to complete the excavation of one burial.

Let us consider what can be done toward correcting these conditions and preserving our mound sites so that the future of Florida archeological research will be assured. Education and legislation are the two possible approaches to a solution. Education will un-

doubtedly be the most far reaching and effective. Legislative action will be necessary eventually; but at the present time the passage of a mound conservation law would be difficult and if passed there is no state agency that could or would assume the responsibility of enforcing such an act. A number of states have such laws and these laws have been very effective, but years of educational efforts preceded their enactment.

An educational program can best be started in our public schools, and in our various organizations for boys and girls such as the Boy and Girl Scouts. If we can teach our youth the value of such protection, their influence will go a long way toward converting their parents. Another very effective measure will be to approach the land owners on whose property mounds are located and persuade them that the mounds need protection and get them to post their property. A well planned series of newspaper articles will probably be very helpful as a preliminary to such effort.

In conclusion, if things are allowed to continue as they are, the future of archeological research in Florida is very dark. If, however, a corrective program is initiated at once, many valuable sites can still be saved, and research workers in Florida can contribute a wealth of information toward recreating the complex history of the original inhabitants of Florida and the southeastern United States.

SOME ASPECTS OF THE NAVAL STORES PROBLEM

J. E. Hawkins, C. K. Clark, W. D. Stallcup and C. R. Stearns
University of Florida

In the production of turpentine and rosin there is a major difficulty that merits attention from scientists. The same condition obtains here as elsewhere; namely, overproduction, and the problem seems to be to find new and, more importantly, permanent uses for these raw materials. As might be expected, the federal conservation program of curtailment of production, by means of bonus offers for not producing, has proved to be no lasting solution. In addition there has been telling competition from synthetics and substitutes. Suggested as means for increasing consumption are more economical processing and finding new uses for turpentine and rosin and their products. Apart from the work of a few nationally known investigators in this field, some accomplishments have been credited to workers in the Department of Chemistry at the University of Florida. The authors suggest possibilities for further research along certain lines, and the need for stimulating interest in naval stores by-products.

OVUM AND SPERMATOZOON AGE AND THE COURSE OF DEVELOPMENT AND GESTATION IN THE GUINEA PIG

William C. Young
Yale Laboratories of Primate Biology, Orange Park

In an initial experiment 462 female guinea pigs were inseminated artificially either prior to ovulation (control group) or 8, 14, 20, 26 or 32 hours after ovulation and observed until the end of pregnancy. A second experiment involved a comparison of unimplanted ova removed from 8 animals inseminated before ovulation with unimplanted ova removed from 35 animals inseminated 14 hours after ovulation. In a third experiment the structure of implanted, normal 8-to-16-day embryos was compared with that of implanted embryos from females in which insemination had been made 14 hours after ovulation.

As the interval between ovulation and the time of fertilization increased, the percentage of sterile inseminations increased, average

litter-size decreased, the percentage of normal pregnancies decreased, and the percentage of pregnancies which were terminated by death of the embryo and abortion increased. Most abortions which were attributable to the age of the ovum at the time of fertilization occurred during the first half of the 68-day gestation period. The abortions and still-births which occurred, particularly after the fifty-fifth day, were as common in the control group as in the experimental group and were attributed to other causes whose nature is not known (Blandau and Young, *American Journal of Anatomy,* 1939).

A complementary study involved the determination of the effect of prolonged residence in the female genital tract on the fertilizing capacity of spermatozoa. Female guinea pigs with known reproductive cycles were inseminated artificially shortly before an expected heat period and then observed continuously until heat occurred. In this way the interval between the time of insemination and the beginning of heat was determined. Since ovulation usually occurs about 10 hours after the beginning of heat, the interval between insemination and fertilization was considered to be 10 hours longer than that between insemination and the beginning of heat.

One hundred and fifty-two females were inseminated 1 to 122 hours before heat. Seventy-four control animals were inseminated during heat. In no instance was the fertilizing capacity retained longer than 22½ hours. The frequency of fertilization showed a marked decrease only after 18 hours. Since the percentage of fertile inseminations then decreased rapidly and the frequency of pregnancies terminated by abortion was not greater in the experimental than in the control group, an all-or-none capacity of spermatozoa to effect fertilization under these conditions is indicated. Furthermore, in contrast to those attributable to delayed fertilization of the ova, the abortions which followed delayed fertilization of spermatozoa occurred during the second half of the gestation period and therefore at a time when germinal defects do not appear to be responsible.

As a consequence of the two series of experiments the following conclusion seems likely:

In the guinea pig both the ovum and spermatozoon are short-lived cells, but they differ in at least one important respect. In the case of the ovum, there is an impairment of function before the capacity for development is lost which is responsible for abnormal development and gestation. The spermatozoon, on the other hand, either appears to effect fertilization which is followed by normal development, or is unable to fertilize the ovum and no development occurs.

SUPERSTITION AND SCIENCE IN THE FIELD OF MENTAL ILLNESS

PHILIP WORCHEL
Florida State Hospital, Chattahoochee

The evolutionary development of man's understanding and control of natural phenomena depended upon his adherence to certain techniques and methods of observation and experimentation. The interpretation of man's behavior has developed more slowly than the study of natural phenomena. In both fields we find a similar struggle of superstition versus the scientific method, and the gradual replacement of superstitious beliefs by knowledge acquired through scientific research.

The present paper has as its main purpose the description of man's attempt to understand the extreme behavioral abnormalities, and the gradual recognition of the value of the scientific method in the investigation of such behavior. From antiquity to the present day, the drama of the evolution from a concern with witchcraft and spirits to carefully controlled experimentation is described. Verbal magic, that is, the manipulation of words and the use of vague abstractions to demonstrate scientific validity, is viewed in the same category as witchcraft.

Controversial issues, such as the question of the adequacy of the scientific method in investigating these behavioral manifestations and the problem whether concepts other than those now employed by the biological and physical sciences must be introduced in order to understand such phenomena as consciousness and thinking, are included in the discussion.

Finally, by a review of the present practices and results in the psychiatric and allied fields, those trends are indicated which offer most hope for the study of these serious abnormalities.

RAMAN SPECTRA OF DIMETHYLENECHLORHYDRIN AND NONAMETHYLENECHLORHYDRIN

R. C. WILLIAMSON
University of Florida

In the following are presented the Raman wavenumber frequencies for two of a series of chlorhydrins. The dimethylenechlorhydrin was

secured from the Eastman Company (b.p. 38.5 — 40.5°/17 mm). The nonamethylenechlorohydrin was prepared by George W. Anderson, Chemistry Department, University of Florida (b.p. 138.5—139°/10 mm; m.p. 28°). Both compounds were redistilled to reduce fluorescent impurities. The spectrograms were made on a glass instrument with a dispersion of 26 Ångstroms/mm at 4900 Ångstroms. Mercury arc excitation was used, screened with an Eastman 2A filter to reduce the 4046 Ångstrom group. An iron spark was used to obtain a comparison spectrum for determination of wavelengths. The wavenumbers are tabulated below, with intensity estimates on a scale of 0 to 5.

Dimethylenechlorhydrin		Nonamethylenechlorhydrin		
$\tilde{\nu}$	Int.	$\tilde{\nu}$	Int.	
294	0	230	0	
396	1			
474	0			
664	5	651	3	
748	3	720	3	
851	3			
941	2			
1032	3			
1079	0	1080	1	
1180	0			Diffuse band between these lines.
1241	1			
1291	0	1302	2	
1431	1	1439	3	
1455	1			
2874	2	2851	4	Diffuse band superimposed on this region.
		2897	4	
2962	4			
3010	2	2997	1	

The principal changes in the spectrum in passing from the two-carbon molecule to the nine-carbon molecule are as follows: the C-Cl frequency decreases from 664 to 651 cm-1, the C-H frequency decreases from 2874 to 2851 cm-1; a strong C-H line develops with a frequency of 1897 cm-1; general diffuse bands develop in the regions 1080 to 1302 and from 2851 to 2960 cm-1.

More detailed results on the whole series will be published later.

THE PTERIDOPHYTES OF FLORIDA

MARY B. DIDDELL
Jacksonville

The recognized authority on ferns for this state, viz., Small's *Ferns of the Southeastern States,* records 141 species as occurring in Florida, which are distributed in 6 orders, 14 families and 56 genera. About a dozen are cultivated species which have become naturalized, while 15 are endemic to Florida.

Although ferns grow abundantly all over the state, there are three conspicuous areas of growth; viz., the Chipley-Marianna section in west Florida, the lime sink region of central Florida and the tropical section south of Lake Okeechobee.

The western area is unique in that it exhibits the southern extension of two northern species, *Onoclea sensibilis* and *Equisetum prealtum,* as well as two representatives from the tropical regions, *Asplenium verecundum* and *Cheilanthes microphylla.*

The lime sink region comprises the original Oligocene Island and, since it is underlaid with lime rock that dissolves easily, it contains many sinks that furnish equable temperature and humidity which are so acceptable to all ferns. Among them are several calciphilous species of Asplenium and one Pteris. Some West Indian species occurring in this area, but not in the tropical area are *Asplenium hetrochroum, A. auritum, A. cristatum, A. pumilum, Blechnum occidentale* and *Hypolepis repens* — all rare except the first and last mentioned.

In the tropical area we find *Dryopteris ampla,* the only true tree-fern native in the United States, with a definite trunk two feet or more high and a spreading crown of delicate, lace-like leaves that exceed six feet in length. About the shores of Lake Okeechobee grow the giant Menisciums, of which there are two species that attain a height of ten feet or more. In the hammocks below Homestead, *Nephrolepis biserrata* clambers and scrambles over the surrounding vegetation until the fronds reach a prodigious length. One specimen collected measures 27 feet 3 inches long. Two climbing ferns, *Stenochlaena kunzeana* and *Phymatodes hetrophyllum,* also attain great length although the fronds are relatively small.

Then, there are several species evenly distributed over the entire state; viz, *Phlebodium aureum* and *Vittaria lineata,* as well as the little resurrection fern, *Marginaria polypodioides.* Likewise, there are some of the species belonging to the Atlantic seaboard that extend into our state, *Osmunda cinnamomea, O. regalis, Lorinseria areolata,*

Anchistea virginica, Pteris pseudocaudata, some of the Dryopteris.

Indeed, such a paradise for ferns is this state of ours that every effort should be made to teach the public their artistic value, both subjectively and objectively.

CERTIFICATION REQUIREMENTS FOR TEACHING SCIENCE IN THE HIGH SCHOOLS

ROBERT I. ALLEN

Stetson University

A comparison of the certification requirements for science and other fields in regard to both Florida and a selected group of states. Increased requirements for science certification in Florida are suggested.

THE EFFECT OF COLD STORAGE ON CERTAIN NATIVE AMERICAN PERENNIAL HERBS

PART II

HERMAN KURZ

Florida State College for Women

The present paper is the continuation of Part I which appeared under identical title in Vol. 2 (1937) of the *Proceedings of the Florida Academy of Sciences.* In Part I the writer indicated that additional experiments were in progress in order to check certain conclusions cautiously worded in that paper and to seek answers to other questions that have naturally arisen as the work proceeded.

A total of twenty-seven species representing twenty-four genera and fourteen families of flowering plants and one species of ferns are represented in Parts I and II combined.

Relying on duplicate cultures and data, the writer has shown that *Actaea alba,* wild ginger *(Asarum canadense),* and *Caltha palustris, Claytonia virginica, Dicentra cucullaria, Erythronium americanum, Geranium maculatum, Hepatica triloba,* larger blue Flag *(Iris versicolor), Lilium canadense, Phlox divaricata, Podophyllum peltatum,* Jacob's ladder *(Polemonium reptans), Sanguinaria canadensis, Smilacina racemosa, Symplocarpus foetidus,* and *Trillium grandiflorum* definitely require a period of chilling for their best development. In

all probability, *Anemone virginiana* and *Monarda fistulosa* belong to this aggregation. From the behavior of this group of species it is concluded that this chilling requirement restricts twelve of these nineteen species to latitudes farther north than Florida.

Five of the above, however, are represented by northern forms for which a low temperature period is necessary, but also by a southern form for which it is not. These five are: *Actaea alba, Hepatica triloba, Podophyllum peltatum, Phlox divaricata,* and *Sanguinaria canadensis.* All of these five southern forms occur in northern Florida.

Duplicate cultures justify the conclusions that some species in terms of ultimate growth are not noticeably affected by refrigeration with the temperature used in this work. These species were *Adiantum Pedatum, Caulophyllum thalictroides,* shooting star *(Dodocatheon meadia), Hepatica acutiloba, Isopyrum biternatum, Lilium superbum, Anemonella thalictroides.* Of this group, peculiarly enough, only the last three are found in Florida.

It has been shown that in such species as *Geranium macalatum* and *Claytonia virginica* vegetative and reproductive growth may be induced earlier by subjecting them to an earlier period of refrigeration. Treated in the same way *Dicentra cucullaria* and *Smilacina racemosa* produced only earlier vegetative growth. *Phlox divaricata* responded hardly at all to early cold storage.

The responses of Sanguinaria canadensis and Erythronium americanum are more or less proportional to the time duration of the low temperature. Moreover, species like *Polemonium reptans, Hepatica acutiloba, Hepatica triloba,* and *Sanguinaria canadensis* chilled one season in culture or in the wild may because of lagging effects make some growth and persist to or through the second year without being subjected to cold storage.

Finally, it is concluded that a number of hardy perennial herbs of the North are restricted in their southward extension not so much by the extreme heat of summers as by the fact that the mild winters of the South do not provide the period of chilling required by them.

THE HISTORICAL METHOD IN THE SOCIAL STUDIES

KATHRYN T. ABBEY

Florida State College for Women

One may define history as the effort to recount and describe any portion or phase of the past life of humankind. History may treat

of war, diplomacy, art, institutions, travel, science, industry, biography or thought. The potential range of the historian is as wide as life itself. As it is obviously impossible to emphasize all these aspects equally at the same time, that one is usually stressed which is dominant in the thinking of the age. Thus in the history of today, social and economic patterns and institutions hold the center of the stage. Much of the history which is "rewritten" from time to time appears new not so much because of new material which has been found as because the searchlight has been refocused.

But, whatever the aspect of human life under study and examination the method is much the same. The historian's task is observational, not experimental. Moreover, very few of the observations has he made himself. Indeed it is probable that his results are more reliable when he is estimating the evidence of others because there is less chance of subjective influences coloring his judgment. The observations of social situations are those of unique episodes since nothing in human experience is exactly duplicated.

It is impossible to "retake" a situation in order to observe it more meticulously. Another handicap to the historian is the fact that few observers are prophets of their own scene and can distinguish between that which future events will demonstrate to have been significant and that which is trivial. Not all observations are preserved; many are destroyed through carelessness or even design.

Thus the task of the historian is to unearth all the observations which he can find; then evaluate them and correlate their content. In regard to the first part of his program, he can never be sure that he has reached the end of the quest. Like the scientist, he knows what he knows until he can find out more. The critical estimates of his observations are of two varieties; first, an evaluation of the authenticity and correctness of the evidence; that is internal criticism. Once the evidence, or body of observations, has been properly analyzed, the historian proceeds to piece out his correlations. Here, the psychology of the historian is a real factor as well as his relations to the situation he is describing. An example of this may be easily found in the accounts of the contemporary scene in which the observations are sound but the correlations turn the whole thing into special pleading from start to finish.

Yet in spite of all the difficulties and pitfalls which beset the path of him who studies the social order, his job is supremely necessary and indispensable, for the social order is in evolution and it is as futile to deal with the present without the past as it is to study the leaves of the tree without concern for the trunk and roots.

SAMPLE APPLICATIONS OF RECTILINEAR CORRELATIONAL TECHNIQUES AND PSYCHOPHYSICAL METHODS OF CONCOMITANT VARIATION TO THE CONCEPTS OF INCIDENTAL COMMUNALITY AND CAUSAL EFFICACY

Christian Paul Heinlein
Florida State College for Women

The primary purposes of this paper are: first, to describe some basic differences in mathematical structure between Correlational Techniques (either derived or compounded from the familiar Pearsonian rectilinear "*r*") and Psychophysical Methods of Concomitant Variation; secondly, to describe some basic differences in operation between Rectilinear Correlational Techniques and Psychophysical Methods of Concomitant Variation; thirdly, to describe some basic differences in logical interpretation which result from a comparative evaluation of the symbolic properties inherent in the concepts of Causal Efficacy and Incidental Communality; fourthly, to describe the different types of logical connection which can be effected between these latter concepts and the aforementioned mathematical techniques and methods; fifthly, to differentiate in time both qualitatively and quantitatively the empirical data which educators have ascribed to Rectilinear Correlational Techniques; sixthly, to point out the many spurious interpretations of Causal Efficacy which educators at large have derived and are deriving from the application of Rectilinear Correlational Techniques to qualitatively heterogeneous, ordinal data wholly inconsistent with the fundamental mathematical principles on which the techniques are necessarily and axiomatically based. In conclusion, reasons will be given for the widely spread practice in higher education of projecting spurious interpretations of causal efficacy as if they were genuine facts.

A CUBIC FOOT OF EVIDENCE

Raymond F. Bellamy
Florida State College for Women

On July 29, 1939, approximately a cubic foot of earth was dug from the midden-heap or debris mound of an old Apalachee Indian

village, now the site of the headquarters of the St. Marks National Game Preserve.

It contained bones of deer, bird, turtle, stingaree, and sturgeon fish. It contained many shells of oysters and gastropods. Some of the gastropod shells looked as if the children had tried to copy the clubs and gouges made from them by their parents. Flint chips and pottery fragments also came to light. These fragments showed the typical "slips" and types of decoration common in this region. There was a flint tooth from a toothed wooden war club. There was a geode, largely disintegrated, which had probably been a child's toy. And there was a bit of common brick, evidently a contribution by the white men.

OVOVIVIPAROUS MAYFLIES IN FLORIDA

Lewis Berner
University of Florida

Production of living young in mayflies of North America has been reported in only a single instance. A female of the Genus *Callibaetis* from New York was found to contain fully developed first instar nymphs. Five female *Callibaetis floridanus* Banks were collected near Marianna, Florida, all of which were completely filled with well developed immatures. Examination of additional material from other parts of Florida showed that this condition is habitual in this as well as the other Florida species of *Callibaetis* (probably a new species). A brief description of the gross appearance of the nymph is given and an attempt is made to correlate longevity with ovoviviparity in mayflies.

CYCLO-GEOMETRIC SERIES

Guy G. Becknell
University of Tampa

A cyclo-geometric series of ratio R, referred to base B, is here defined as a geometric progression of rate R, so modified by subtracting the appropriate whole multiple of B from each term that no term shall exceed B-1. Such a series must consist of integers only, and the last term must revert to the first term so that the series is cyclic. Thus, the c.g. series corresponding to base 11 and ratio 8 is: 1 8 9 6 4 10 3 2 5 7.

The series will be called *self-supplementary* since 1 + 10 = 8 + 3, etc. = 11, the base. But c.g. series become useful when we reduce the terms to a scale of notation whose radix is equal to the ratio of the series, and then write below these terms the digits of the repetend corresponding to the reciprocal of the base. For base 19 and ratio 10, with repetend for 1/19, we have:

1 10 5 12 6 3 11 15 17 18 9 14 7 13 16 8 4 2
.0 5 2 6 3 1 5 7 8 9 4 7 3 6 8 4 2 1

The rule for deriving the c.g. series when the base ends in the digit 9 is: increase the tens digit of the base by 1; divide this number, the *primary divisor,* into each term to produce the next following one, setting down the quotient in the units place and the remainder in the tens place.

The decimal series, or repetend, is derived by multiplying the units digits in the c.g. series by 1, (radix minus units digit of base) and setting down the units digit of the product below and one place to the left of the c.g. series term. This is a *complementary* series, since the digits in order by pairs add up to 9 (base minus 1). The repetends representing 18 different common fractions are shown in the last series. For example, the repetend for 11/19 is .57894736842152631.

Corresponding to the primary divisor there is always a *secondary divisor,* such that primary plus secondary equals the base. To illustrate the use of the secondary divisor take a prime base ending in digit 1, for which the secondary divisor always equals the tens digit. The following are the two c.g. series and the corresponding decimal series for base 31 and ratio 10.

1 10 7 8 18 25 2 20 14 16 5 19 4 9 28
.0 3 2 2 5 8 0 6 4 5 1 6 1 2 9
* * *
30 21 24 23 13 6 29 11 17 15 26 12 27 22 3
.9 6 7 7 4 1 9 3 5 4 8 3 8 7 0

The two c.g. series are supplementary and the decimal series complementary to each other. In the first c.g. series divide the second term by 3, the secondary divisor, as for a primary divisor. This forms the number 13. In this subtract the units digit from the tens number. This gives 7 as the third term. Dividing the fifth term by 3 gives the quotient 6, which subtracted from the base leaves 25 as the sixth term. All secondary divisors are used in this manner. The decimal series is derived as before for numbers ending in digit 9, except that the multiplier is 9 instead of 1.

The method for deriving the c.g. series and corresponding repetends for bases ending in digits 3 or 7 are similar to those already shown for digits 1 and 9. Other general rules to aid in the rapid formation of c.g. series are illustrated in the paper.

Analytic proofs for the rules are included, and the factorability of self-complementary repetends is shown as well as other unique properties which they possess.

OBSERVATIONS ON CAPTIVE PORPOISES

ARTHUR F. McBRIDE

Marine Studios, Marineland

The bottle-nosed dolphin *(Tursiops truncatus)* was first placed in captivity in the New York Aquarium in November, 1913. Observations from below water, however, were not possible. Since February, 1938, Marine Studios has had a school of these porpoises under observation in a tank permitting observations from below water.

As the auditory colliculus of the porpoise brain is four times the size of the corresponding optic colliculus the importance of their sense of hearing is great. It is, therefore, significant to learn that the porpoises communicate with each other by means of a whistling sound usually accompanied by the escape of air from the blowhole.

From examinations of the eyelids of freshly killed Odontocetes it was believed that complete closure was impossible. Observations on the living porpoise show that the eyelids can close completely.

The eyeballs of all Cetacea were believed to be immovable. Observations on the living porpoise show that the eyeball is capable of moving.

In spite of the specialization of the porpoise's eye for underwater vision the animal still retains the ability to perceive moving objects in air for a short distance.

At least one-third of the porpoise's day is spent in sleep. At these times the body is completely relaxed for many minutes and the eyelids periodically close.

There are dominant and submissive animals in the porpoise school. Intimidations and actual fighting determine positions in the school.

Courtship was observed during the early spring months. One female, in mid-October, is in an advanced state of pregnancy.

Young porpoises nurse underwater and because milk is forcefully ejected from the mammary gland the operation takes only a few seconds.

WORD DANGERS IN SCIENTIFIC THINKING

EARL L. VANCE
Florida State College for Women

Thinking must be in terms of symbols of which words are by far the commonest. But many word symbols mean different things to different persons. Easy examples are such words as "liberal," "radical," "freedom," etc. Still other words have virtually no meaning except in terms of their relation to other concepts or objects. Examples are such words as "loyalty," "patriotic," "cooperation," etc.

These words are dangerous to scientific thinking, not only because they carry no precise meaning in themselves, but even more because many of them have strong emotional connotations. "Non-cooperation" can be a cause of action sentencing one to a bread line; "disloyalty" or "un-Americanism" can send him to jail—but all of these terms are meaningless except in relation to the objects requiring cooperation, loyalty, or to the particular definitions of "Americanism."

Long usage gives accepted values to terms, which values often will not bear critical examination. An example of this is the term "social science." Strictly speaking there is hardly a social "science"; yet it has come to be accepted that anything done in any of several college departments is a "social science."

Scientific thinking must in the last analysis think through symbols to the exact meaning. It must be wary of all generalized words, particularly those carrying highly emotional connotations.

FOREST LAND INCOME FROM NAVAL STORES IN ALACHUA COUNTY, FLORIDA, IN 1937

E. A. ZIEGLER
University of Florida

Although the market prices of naval stores in 1937 were at the highest point since 1929, they were about at an average for the past 20 years. Therefore, the 1937 study of pine land income has more than momentary value.

Two groups of students in Forest Economics in the senior class of the Forestry School at the University were enlisted in (1) a complete financial analysis of the naval stores industry in Alachua County in 1937, and (2) a study of forest taxation in the same county

for the same year. These studies were part of a program of studies to throw light on the economic feasibility of sustained-yield forest management in north Florida.

(1) The survey of the naval stores industry revealed that of the approximate total of 396,000 acres of forest (68% of the land area) in Alachua County, 97,000 acres are owned and 53,000 acres leased by 14 naval stores operators (17 stills). These operators worked 198 "crops" (10,000 faces each) and produced 9,250 bbl. (50 gal.) of turpentine and 3 1/3 times this number of barrels (500 lb. gross) of rosin or 9,250 "units" in the language of the industry. The average net sale value at Jacksonville (selling costs deducted) was $59.06 per "unit" or for the county production, $546,305.

Deducting the costs, including all items of labor, materials, transportation, superintendence, interest on capital (exclusive of land) and an item of 12% of the cost of the product at the still for "profit and risk," left $619.71 as the timber value per 10,000 cups or about 6.2 cents per cup. Since the average of 757 acres was required to hang 10,000 cups, the naval stores timber income to the land owner was about $.82 per acre. From this had to be deducted $.16 for taxes, leaving a net land income of $.66 per acre. To this could be added any income from grazing cattle (about 5 cents per acre) where the owner grazed his own land or leased it for grazing. Also a potential income exists of about $.15 per acre annually for pulpwood from worked out trees, valuing the pulpwood at $1.00 per cord stumpage.

Prices in 1938 were only $40.92 per "unit" (1 bbl. turpentine and 3 1/3 500 lb. bbl. of rosin) against $61.45 (gross or including selling costs) in 1937. In 1939 prices will average about the same—possibly a bit higher; hence, for these two years the net land income, allowing for reduced wages, would not be much over $.15 to $.20 per acre from naval stores alone.

(2) Forest taxation was analyzed by securing the sale value, assessed value, and the taxes on 177 random properties sold, having an acreage total of 17,527 acres. All forced sales were avoided. The properties could only be separated into 4 value classes:

up to $ 9.99
$10.00— 14.99
15.00— 24.99
25.00— and up

The first class was chiefly forest land—the other classes had increasing agricultural values included in the price.

The first class (largely second growth forest) was assessed at 89% of its sale value and paid a tax of $.18 an acre. The other 3 classes were assessed at 39%, 27%, and 24% of sale value, respectively.

THE SUN—A COMPONENT OF A BINARY SYSTEM

J. Francis Knorr, Jr. and Arnold Edmund Hayes
Stetson University

This paper offers a possible solution of one of the most puzzling problems related to the structure of the solar system, namely, the perturbations in the orbital motions of the outer planets, Uranus, Neptune and Pluto. It endeavors to show that the Sun is possibly the primary of a binary system—a relationship that is not unreasonable in view of the fact that twenty per cent of the known stars are binaries.

The paper suggests that the secondary component is a small dark star of great density revolving, at a distance of approximately sixty astronomical units, together with the Sun around a common center of gravity.

The reasons advanced for attempting this study are first, the discrepancies between the actual orbits and the computed orbits of the three outer planets; second, certain conclusions that may be drawn from a study of several hypotheses on the origin of the solar system; and third, the unexplained motion of the solar apex.

From the data available the physical characteristics of the secondary are deduced. It would seem to be a dwarf star with a density 30,000 times that of water, a volume .0065 that of the Earth and a diameter in the neighborhood of 1,500 miles.

Other data indicate a period of revolution of approximately five hundred years.

THE NATIONAL SURVEY OF SCIENCE TEACHING

W. Leroy MacGowan
Lee High School, Jacksonville.

The Department of Science Instruction of the National Education Association has instituted a National Committee on Science Teaching composed of representatives from the American Association for the Advancement of Science, American Association of Physics

Teachers, American Chemical Society, American Nature Study Society, American Science Teachers Association, Association of Science Teachers of the Middle States, Central Association of Science and Mathematics Teachers, National Association of Biology Teachers, National Association for Research in Science Teaching, National Council of Elementary Sciences, National Council of Geography Teachers. In addition, there are nearly 200 consultants cooperating with the general committee. The work of the committee is being carried forward by means of six sub-committees: on Philosophy or Frame of Reference, on Evaluation, on Social and Personal Needs in Relation to the Science Program, on Teachers Education, and on Administrative Problems for Teaching of Science.

The formation of this committee on a national scale indicates a desirability that science teaching and science organizations, such as this Academy, should concern themselves with the problem of the improvement of science instruction.

REPORT OF THE SECRETARY

The membership of the Academy has, during 1939, continued its slow but steady rate of increase. The figures since the first Annual Meeting are as follows:

November, 1936—236
November, 1937—262
November, 1938—285
November, 1939—321

With the development of the Social Sciences Section and the Junior Academy, both meeting for the first time at this annual meeting, the increased scope of functioning of the Academy will probably bring a considerable growth in the membership within the area of the social sciences and among high school science teachers. In this connection, it is suggested that the members of the Academy lend whatever encouragement they can to the active participation in the work of the Junior Academy on the part of high school science groups. Although the Junior Academy is an independent self-governing organization, it is sponsored by the Academy and was formed under the guidance of an Academy committee, which will continue to function in an advisory capacity.

During the past year, the Council held a spring meeting in Lakeland and a fall meeting in Gainesville. The Council transacts Academy business continuously, of course, by correspondence, but these two meetings to plan and organize Academy activities have been invaluable. The fact that these meetings are held at the personal expense of the members of the Council is testimony of the loyal service which they render to the Academy.

The Council has awarded the 1939 Research Grant of $50 to Miss Ruth Schornherst, Florida State College for Women, for use in connection with her study of the mosses of Florida.

The attention of the members of the Academy is invited to the improvements in the format of the *Proceedings,* as exemplified in Volume 3. The Editor and Managing Editor have given considerable study to this matter and have evolved a format which fits the needs of the situation and is at the same time based upon the finest canons of style for scholarly publications, as described in the *Manual of Style* of the University of Chicago Press. Further improvement is, of course, possible and to be expected. The editorial staff feels, however, that con-

siderable progress has been made toward developing a dignified and attractive volume. The staff will be glad to receive suggestions for further improvement from any member of the Academy.

November 18, 1939 J. H. KUSNER, *Secretary.*

REPORT OF THE TREASURER

(As of November 15, 1939)

Income:

Balance carried forward from November 15, 1938		$319.54
Dues Received:		
1937 4 memberships	8.00	
1938 63 memberships	126.50	
1939 165 memberships	331.50	
1940 10 memberships	20.00	
		486.00
1938 4 associate memberships	$ 4.00	
1939 12 associate memberships	12.00	
1940 1 associate membership	1.00	
		17.00
1938 Institutional Sustaining Membership	$100.00	
1939 Institutional Sustaining Membership	290.00	
		390.00
Receipts from sale of *Proceedings*: Volume 1	$ 12.00	
Volume 2	33.00	
Volume 3	20.00	
		65.00
Receipts from authors for *Proceedings* reprints and cuts	$269.92	
	4.50	
		274.42
A. A. A. S. Research Grant	50.00	
		50.00
Book Adjustment, J. H. Kusner 12/10/39	4.00	
		4.00
TOTAL		$1,605.96

Disbursements:

Publishing of *Proceedings*: Volume 1	$106.80	
Volume 2	637.73	
	45.04	
		$789.57
Typing of manuscript for *Proceedings*	17.75	
	8.40	
	3.75	
	26.80	
		56.70

Administrative Expenses:		
Secretary's office—postage and stationery, express and freight	73.83	
		73.83
Treasurer's office—postage and stationery	13.55	
		13.55
Business Manager's office—1938	2.84	
		2.84
Publishing of Programs—1938 meeting	16.25	
		16.25
Research Grant, 1939, Ruth Schornherst	50.00	50.00
Miscellaneous: Reassignment of dues (Kinsler)	2.00	
Book Adjustment (Kusner 11/25)	4.00	
Refund to H. F. Carr, overpayment 4/19/39	11.00	
		17.00
TOTAL		$1,019.74
TOTAL RECEIPTS	$1,605.96	
TOTAL DISBURSEMENTS	1,019.74	
BALANCE	$ 586.22	
Accounts Receivable		
Proceedings sold		$ 5.00
Reimbursements from authors		181.27
Institutional memberships unpaid		135.00
Regular memberships unpaid, 1939		278.00
TOTAL		$324.05
Accounts Payable:		
H. & W. B. Drew Co., Materials for binding		$ 4.70
Pepper Printing Co., Programs		29.20
University of Florida, Mimeographing materials		22.50
Expenses of Secretary's Office		36.79
Expenses of Committee on School Science		31.17
		$124.36

E. Morton Miller, *Treasurer*

THE ACHIEVEMENT MEDAL FOR 1939

The Achievement Medal of the Florida Academy of Sciences is Awarded annually for a noteworthy paper presented at the annual meeting. The Editorial Committee of the *Proceedings* functions as a medal committee for this purpose.

For 1939, the medal was awarded to Robert B. Campbell, Peninsular Oil & Refining Company, Tampa, for his paper "Outline of the Geological History of Peninsular Florida," published in this volume, pp. 87-106.

RESOLUTION CONCERNING THE SOCIAL SCIENCES[1]

The Florida Academy of Sciences, assembled in its Fourth Annual Meeting, takes this occasion to signalize an important step in the Academy's development.

As stated in its charter, the purposes of the Academy are "to promote scientific research, to stimulate interest in the sciences, to further the diffusion of scientific knowledge, to unify the scientific interests of the state, and to issue an annual scientific publication." Until this time, however, the activities of the Academy have been almost entirely in the fields of the biological and physical sciences. With the appearance of the Social Sciences Section in the program of this meeting, the scope of the Academy's functioning has more nearly developed to the extent implied in its charter. This development is in the finest tradition of academies of science, and is of great importance in that the bringing together of the active workers in the biological, physical and social sciences in Florida for an annual meeting in which there can be discussed the inter-relationships of these fields, as well as their more detailed phases, will inevitably be of value to workers in every field.

By becoming an academy of *all* of the sciences, the Academy's opportunities for effective service become as broad as the vast range of problems which today face a troubled world.

The Academy feels that with this step it has moved forward substantially toward the fulfillment of its purpose "to unify the scientific interests of the state," and it takes this occasion to extend, on behalf of the biological and physical scientists within its membership, a warm welcome to their fellow scientists in the various fields of the social studies.

[1]Adopted unanimously at Fourth Annual Meeting.

PROGRAM OF THE FOURTH ANNUAL MEETING

FLORIDA STATE COLLEGE FOR WOMEN

NOVEMBER 16, 17 AND 18, 1939

FIELD TRIPS

1. Florida State Hospital & Torreya or Cavern State Park. Thursday, all day or afternoon.
2. Wakulla Springs, St. Mark Lighthouse, Underground Lake and Natural Bridge. Saturday afternoon.
3. Indian Mounds, Lake Jackson. Friday 4:30-6:30 p. m.
4. Telescopic observation of selected heavenly bodies. Thursday, 7:30-9:30 p. m. (weather permitting).
5. Exhibits open all day Thursday and Saturday morning:
   A. State Geological Survey Museum.
   B. State Forestry and Park Service Offices.
   C. State Chemistry Laboratory.
   D. Division of Malarial Laboratories Research.

FRIDAY, NOVEMBER 17

9:30-10:30 A. M.—1st GENERAL SESSION—Augusta Conradi Theater, History Building.

President B. P. Reinsch presiding

1. Some Aspects of the Naval Stores Problem—J. E. Hawkins, Associate Professor of Chemistry and Associate Director of Naval Stores Research, C. K. Clark, W. D. Stallcup, and C. R. Stearns, Graduate Students, University of Florida. 10 min.
2. Shark Fishing Industry of Florida—L. L. Rusoff, Assistant Professor of Animal Nutrition, University of Florida. 15 min.
3. The Mayan Calendar—C. V. Imeson, Chattahoochee. 20 min.

10:30-10:45 A. M.—INTERMISSION.

10:45 A. M.-Noon—2nd GENERAL SESSION—Augusta Conradi Theater, History Building.

President B. P. Reinsch presiding

1. Geography and the Social Sciences: Mutual Responsibilities in the Teaching of the Physical and Social Sciences—R. S. Atwood, Professor of Geography and Chairman, Man and the Social World, University of Florida. 30 min.
2. The Historical Method in the Social Studies—Kathryn T. Abbey, Professor of History, Florida State College for Women. 20 min.

12:15-12:45 P. M.—Film from Marine Studios. St. Augustine State Theater, 108 East College Ave.

1:45-3:00 P. M.—3rd GENERAL SESSION—Augusta Conradi Theater, History Building

President B. P. Reinsch presiding

1. Outline of the Geological History of Peninsular Florida—R. B. Campbell, President, Peninsular Oil & Refining Co., Tampa. 20 min.
2. The Problem of Florida Archeological Research (Report of the Conservation Committee)—S. A. Stubbs, Assistant State Geologist. 15 min.
3. Effects of Immersion on the Hemograms of Swimmers—L. Y. Dyrenforth, Pathologist, St. Luke's and Riverside Hospitals, Jacksonville. 10 min.
4. The National Survey of Science Teaching—W. L. MacGowan, Head Department of Biology, Lee High School, Jacksonville, Supervisor of Biology, Duval County. 5 min.

3:00-3:30 P. M.—INTERMISSION.

3:30-5:30 P. M.—SOCIAL SCIENCES SECTION, 1st meeting—Room 303, Westcott Building

Chairman R. S. Atwood presiding

1. The Development of the Social Sciences in the Southeast—J. M. MacLachlan, Assistant Professor of Sociology, University of Florida. 30 min.
2. Word Dangers in Scientific Thinking—Earl L. Vance, Associate Professor of Journalism, Florida State College for Women. 15 min.
3. Sample Applications of Rectilinear Correlational Techniques and Psychophysical Methods of Concomitant Variation to the Concepts of Incidental Communality and Causal Efficacy—C. P. Heinlein, Professor of Experimental Psychology, Florida State College for Women. 20 min.
4. Discussion: (40 min.).
   a. Relationships between the Physical and Social Sciences.
   b. The Teaching of *Social Science* versus the Teaching of *the* Social Sciences.

3:30-4:30 P. M.—BIOLOGICAL SCIENCES SECTION, 1st meeting—Room 307, Science Building

Chairman G. G. Scott presiding

1. Distribution and Species of North American *Progomphus*—C. F. Byers, Assistant Professor of Biology, University of Florida. 15 min.
2. The Scientific Status of Fish Culture and Lake Management in Florida—O. L. Meehean, Assistant Aquatic Biologist, Bureau of Fisheries, U. S. Dept. of the Interior, Welaka. 15 min.
3. A Marine Biological Laboratory on the Gulf Coast of Florida—A. E. Hopkins, Director, Fisheries Biological Laboratory, Bureau of Fisheries, U. S. Dept. of the Interior, Pensacola. 15 min.
4. Preliminary List of *Myxomycetes* from Alachua County—Erdman West, Mycologist, Florida Agricultural Experiment Station. By title.

3:30-4:30 P. M.—PHYSICAL SCIENCES SECTION, 1st meeting—Room 403, Education Building

Chairman A. A. Bless presiding

1. Tests for Determining Prime Factors—G. G. Becknell, Professor of Physics, University of Tampa. 15 min.
2. Catalytic Hydrogenation of Oleo-Resin from the Slash Pine—Charles R. Stearns, Jr., Graduate Student and J. E. Hawkins, Associate Professor of Chemistry and Associate Director of Naval Stores Research, University of Florida. 10 min.
3. Resin Acids II: Dehydroabietic Acid and Certain of Its Derivatives—W. D. Stallcup, Graduate Student and J. E. Hawkins, University of Florida. 10 min.,
4. The Vapor Phase Oxidation of Alpha Pinene—C. K. Clarke, Graduate Student and J. E. Hawkins, University of Florida. 10 min.

4:35-5:30 P. M.—Joint meeting, BIOLOGICAL AND PHYSICAL SCIENCES SECTIONS—Room 403, Education Building

Chairman G. G. Scott, Biological Sciences Section, presiding

1. Ecologic Significance of *Foraminifera* from Seven Stations in the Vicinity of Biscayne Bay—S. A. Stubbs, Assistant State Geologist. 15 min.
2. A Preliminary Note on the Vitamin A Content of the Liver Oil of the Florida Lemon Shark (*Hyproprion Brevirostris Poey*)—L. L. Rusoff, Assistant Professor of Animal Nutrition, University of Florida. 5 min.
3. Biological Effects of Radiations of Different Wave Lengths—A. A. Bless, Professor of Physics, University of Florida. 10 min.
4. The Certification Requirements for Science Teaching in High School—R. I. Allen, Professor of Physics, Stetson University. 5 min.
5. The Reaction of Magnolia, Scrub Live-Oak, and other Plants to Dune Activity on the West Florida Coast—Herman Kurz, Professor of Botany, Florida State College for Women. 10 min.

6:30 P. M.—BANQUET—(Informal)—College Dining Hall.

Toastmaster: R. I. Allen, Past President of the Academy.

Address of Welcome: Edward Conradi, President, Florida State College for Women.

Retiring Presidential Address: B. P. Reinsch, President of the Academy.

Presentation of the Achievement Medal for 1938: L. Y. Dyrenforth, Chairman, Medal Committee.

8:00 P. M.—Joint meeting of the Academy and the Florida Section of the American Chemical Society—Augusta Conradi Theater, History Building

Gertrude Vermillion, Florida State College for Women, Chairman of the Florida Section of the American Chemical Society, presiding

The Nature of Clays and Soils—S. B. Hendricks, Bureau of Chemistry and Soils, U. S. Dept. of Agriculture, Washington, D. C.

9:00-11:00 P. M.—Reception to members of the Academy, given by President Edward Conradi, Florida State College for Women—Cary D. Landis Hall.

SATURDAY, NOVEMBER 18

8:30-10:30 A. M.—BIOLOGICAL SCIENCES SECTION, 2nd meeting—Room 307, Science Building.

Chairman G. G. Scott presiding

1. The Monarch Butterfly (*Danaus menippe*) in Florida—H. T. Fernald, Orlando, Emeritus Professor of Entomology, Massachusetts State College. 5 min.
2. The Effect of Cold Storage on Certain Native American Perennial Herbs, Part II—Herman Kurz, Professor of Botany, Florida State College for Women. 10 min.
3. Ovoviviparus Mayflies in Florida—Lewis Berner, Graduate Assistant in Biological Sciences, University of Florida. 5 min.
4. A Brief History of Tomato Production in Florida—G. F. Weber, Professor of Plant Pathology, University of Florida. 5 min.
5. Notes on the Breeding Habits of the Warmouth Bass—A. F. Carr, Jr., Instructor in Biological Sciences, University of Florida. 5 min.
6. The *Pteridophytes* of Florida—Mary W. Diddell, Jacksonville. 10 min.
7. Florida Pocket-Gopher Burrows and Their Arthropod Inhabitants—C. C. Goff (deceased), Assistant Entomologist, Florida Agricultural Experiment Station and T. H. Hubbell, Professor of Biology, University of Florida. 10 min.
8. Observations on Captive Porpoises—A. F. McBride, Curator, Marine Studios, St. Augustine. 15 min.
9. Ovum and Spermatozoon Age at the Time of Fertilization, and the Course of Gestation and Development in the Guinea Pig—W. C. Young, Yale Laboratories of Primate Biology. 20 min.
10. A Diagnostic Taxonomic Constant for Separating Slash and Longleaf Pines W. B. DeVall, Teaching Fellow in Forestry, University of Florida. 5 min.

8:30-10:30 A. M.—PHYSICAL SCIENCES SECTION, 2nd meeting—Room 403, Education Building.

Chairman A. A. Bless presiding

1. Raman Spectra of Dimethylenechlorhydrin and Nonomethylenechlorhydrin—R. C. Williamson, Professor of Physics, University of Florida. 20 min.
2. Cyclo-Geometric Series—G. G. Becknell, Professor of Physics, University of Tampa. 20 min.
3. The Sun—A Component of a Binary System—J. F. Knorr, Jr., and A. E. Hayes, Students, Stetson University. 25 min.

8:30-10:30 A. M.—SOCIAL SCIENCES SECTION, 2nd meeting—Room 303 Westcott Building.

Chairman R. S. Atwood presiding

1. Masculinity Femininity Responses of Florida State College for Women and University of Florida Students—Dorothy R. Disher, Assistant Professor of Psychology, Florida State College for Women. 20 min.
2. Superstition and Science in the Field of Mental Illness—Philip Worchell, Psychologist, Florida State Hospital, Chattahoochee. 20 min.
3. Forest Land Income from Naval Stores in Alachua County, Florida, in 1937—E. A. Ziegler, Professor of Forest Economics and Finance, University of Florida. 10 min.
4. A Cubic Foot of Evidence—R. F. Bellamy, Professor of Sociology, Florida State College for Women. 15 min.

10:30-10:45 A. M.—INTERMISSION.

10:45 A. M.-Noon—4th GENERAL SESSION—Augusta Condadi Theater, History Building

President B. P. Reinsch presiding

1. What Science Should Be Taught the Children of Florida? Methods of Investigating This Problem—L. L. Boles, Supervising Principal, Groveland Public Schools. 15 min.
2. Cooperation of W.P.A. with University and College Research Programs—M. C. Forster, Consultant on Research Projects, Work Projects Administration, Washington, D. C. 20 min.
3. Mechanics and Sponsorship of W. P. A. Projects—F. E. Albert, Assistant State Director, Professional and Service Division, Work Projects Administration. 20 min.

Noon-12:30 P. M.—BUSINESS SESSION—Augusta Conradi Theater, History Building.

1:30 P. M.—COUNCIL MEETING (New and retiring members)—Room 101, History Building.

PROGRAM OF THE ORGANIZATION MEETING JUNIOR ACADEMY OF SCIENCES OF FLORIDA

(Sponsored by Florida Academy of Sciences)

AUDITORIUM, FLORIDA HIGH SCHOOL, TALLAHASSEE,

9 A. M., SATURDAY, NOVEMBER 18, 1939.

W. L. MacGowan, Chairman Committee on Junior Academy, presiding

1. Address of Welcome—Colin English, State Superintendent of Public Instruction.

2. Conservation—Catherine Pomeroy, Student, St. Petersburg High School.
3. Measuring the Muzzle Velocity of a Bullet—David Russell, Student, Lee High School, Jacksonville.
4. The Flat-Tailed Water Snake—Craig Phillips, Student, St. Petersburg High School.
5. Some Experiments with Invisible Light—Harold F. Richards, Professor of Physics, Florida State College for Women.
6. Business Session.
7. Film Lectures on Scientific Subjects.

SUMMARY OF HIGH SCHOOL STUDENTS AND TEACHERS ATTENDING ORGANIZATION MEETING OF THE JUNIOR ACADEMY OF SCIENCES OF FLORIDA

	Students	Teachers
Bradenton High School	4	1
Clearwater High School	2	2
Jacksonville: Jackson High School	1	0
John Gorrie Junior High School	1	0
Kirby Smith Junior High School	0	1
Landon High School	2	0
Lee High School	22	3
Lee Junior High School	16	1
Quincy High School	3	1
Pensacola: West Chase Junior High School	2	0
St. Petersburg High School	8	1
Tallanassee: Florida High School	2	1
Leon High School	4	1
West Palm Beach: St. Ann's School	0	2
TOTAL	67	14

OFFICERS OF THE JUNIOR ACADEMY OF SCIENCES FOR 1940

PRESIDENT—Earl Smith, *St. Petersburg High School.*

VICE-PRESIDENT—Edwin Adler, *Bradenton High School.*

SECRETARY—Letitia Croom, *Lee High School, Jacksonville.*

TREASURER—Ruth Cobb, *Chase Junior High School, Pensacola.*

OFFICERS OF THE ACADEMY FOR 1939

PRESIDENT—B. P. Reinsch, *Florida Southern College.*

VICE-PRESIDENT—W. L. MacGowan, *Lee High School, Jacksonville.*

SECRETARY—J. H. Kusner, *University of Florida.*

TREASURER—E. M. Miller, *University of Miami.*

CHAIRMAN OF BIOLOGICAL SCIENCES SECTION—G. G. Scott, *Winter Park.*

CHAIRMAN OF PHYSICAL SCIENCES SECTION—A. A. Bless, *University of Florida*

CHAIRMAN OF SOCIAL SCIENCES SECTION—R. S. Atwood, *University of Florida.*

OFFICERS OF THE ACADEMY FOR 1940

PRESIDENT—R. C. Williamson, *University of Florida.*

VICE-PRESIDENT—C. P. Heinlein, *Florida State College for Women.*

SECRETARY—J. H. Kusner, *University of Florida.*

TREASURER—Burton Faust, *Edison Senior High School, Miami.*

CHAIRMAN OF BIOLOGICAL SCIENCES SECTION—Miss Frances L. West, *St. Petersburg Junior College.*

CHAIRMAN OF PHYSICAL SCIENCES SECTION—Guy Waddington, *Rollins College.*

CHAIRMAN OF SOCIAL SCIENCES SECTION—R. F. Bellamy, *Florida State College for Women.*

ADDITIONAL MEMBERS OF THE COUNCIL

EDITOR OF THE PROCEEDINGS—L. Y. Dyrenforth, *St. Luke's Hospital, Jacksonville.*

PAST-PRESIDENT—(1938)—R. I. Allen, *Stetson University.*

PAST-PRESIDENT—(1939)—B. P. Reinsch, *Florida Southern College.*

CHAIRMAN OF CONSERVATION COMMITTEE—S. A. Stubbs, *Florida Geological Survey.*

CHAIRMAN OF COMMITTEE ON SUSTAINING MEMBERSHIPS AND ENDOWMENTS—R. B. Campbell, *Peninsular Refining Company, Tampa.*

CHAIRMAN OF COMMITTEE ON LOCAL ARRANGEMENTS—Miss Helen F. Story, *St. Petersburg Junior College.*

CHAIRMAN OF COMMITTEE ON JUNIOR ACADEMY—W. L. MacGowan, *Lee High School, Jacksonville.*

LIST OF MEMBERS—1939

†Adams, R. H., Miami Senior High School, Miami (Biology)

Allen, E. Ross, Florida Reptile Institute, Silver Springs (Herpetology)

Allen, R. I., Stetson University (Physics)

Anderson, G. W, 376 W. Magnolia St., Gainesville (Chemistry, Physics, Astronomy)

Anderson, W. S., Rollins College (Chemistry)

Armstrong, J. D., Bryceville (Chemistry, Physics)

Arnold, Lillian E., University of Florida (Botany)

Atwood, R. S., University of Florida (Geography)

†Babcock, Louis, M. & T. Building, Buffalo, New York (Ichthyology)

Bangham, Ralph V., College of Wooster, Wooster, Ohio (Parasitology)

Barbour, R. B., 560 Interlachen Avenue, Winter Park (Chemistry)

Barbour, Thomas, Museum of Comparative Zoology, Harvard College, Cambridge, Mass. (Zoology)

Barrows, W. M., Florida State College for Women (Physics)

Beardslee, H. C., Altamonte Springs (Mycology)

†Beck, Dow G., Ocala (Physics)

†Beck, William, Jr., University of Florida (Biology)

Becker, R. B., University of Florida (Agriculture)

Becknell, Elizabeth A., 6900 Dixon Ave., Tampa (Psychology)

Becknell, G. G., University of Tampa (Physics, Mathematics)

Bell, C. E., University of Florida (Chemistry, Soils)

Bellamy, R. Edward, 808 North Jefferson Street, Albany, Ga. (Biology)

Bellamy, R. F., Florida State College for Women (Sociology)

Berger, E. W., University of Florida (Entomology)

Blackmon, G. H., University of Florida (Horticulture)

†Associate member.

Blair, W. Frank, Laboratory of Vertebrate Genetics, University of Michigan, Ann Arbor, Michigan (Biology)
Bless, Arthur A., University of Florida (Physics)
Bly, R. S., Florida Southern College (Chemistry)
†Bogue, Helen, 2526 Post Street, Jacksonville (Biology)
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Buckland, Charlotte B., Landon High School, Jacksonville (Biology)
Bullard, N. H., Board of Public Instruction, Ft. Pierce (Mathematics)
Buswell, Walter M., University of Miami (Botany)
Byers, C. F., University of Florida (Biology)

Calaway, Wilson T., 1674 S. W. 23rd St., Miami (Chemistry)
Campbell, Robert B., 603 Wallace S. Building, Tampa (Geology, Paleontology)
†Carlin, Kathryn L., 248 Rivo Alto Island, Miami Beach (Chemistry)
Carr, A. F., Jr., University of Florida (Biology)
Carr, Mrs. A. F., Jr., 2356 Broome St., Gainesville (Biology)
Cartwright, Geo. H., 626 Chase Ave., Winter Park (Acoustics)
Carver, W. A., University of Florida (Agronomy)
Chandler, H. W., University of Florida (Mathematics)
Christensen, B. V., Ohio University, Columbus, Ohio (Pharmacy)
Clouse, J. H., University of Miami (Physics)
Coghill, G. E., Rt. 2, Box 77A, Gainesville (Anatomy)
Conn, John F., Department of Chemistry, Stetson University (Chemistry)
Conner, Ruth, Florida State College for Women (Home Economics)
Conradi, Edward, Florida State College for Women (Psychology)
Cooper, William C., United States Department of Agriculture, Orlando (Plant Physiology)

Dauer, Manning J., University of Florida (History, Political Science)
†Davis, Barbara J., Apopka (Mathematics, Physics)
Davis, E. M., Rollins College (Ornithology, Entomology)
†Davis, Kathryn, P. O. Box 402, Homestead (Psychology, Botany)
Davis, U. P., University of Florida (Mathematics)
Dell, Mrs. R. G., Bronson (Zoology)
DeMelt, W. E., Florida Southern College (Psychology)
Deviney, Ezda, Florida State College for Women (Zoology)
Dickinson, J. C., Jr., University of Florida (Biology)
Disher, Dorothy R., Florida State College for Women (Psychology)

†Associate member.

Dostal, B. F., University of Florida (Mathematics)
Dowdell, Jane, Box 266, Plant City (Botany)
Doyle, S. R., Florida State College for Women (Biology)
Dyrenforth, L. Y., 1022 Park Street, Jacksonville (Pathology)

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Everett, Helen, Florida Southern College (Biological Sciences)

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Faulkner, Donald, Stetson University (Mathematics)
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Floyd, B. F., Davenport (Horticulture)
Floyd, W. L., University of Florida (Agriculture)
Foote, P. A., University of Florida (Pharmacy)
Freeman, Ellis, University of Tampa (Psychology)
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French, Robert M., Shark Industries, Inc., Hollywood, Florida (Biology)
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George, Theodore S., University of Florida (Physical Sciences)
Gentry, Vernon S., Florida Southern College (Zoology)
Germond, H. H., University of Florida (Mathematics)
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Giovannolli, Leonard, Key West Aquarium (Ichthylogy)
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Grimmer, J. Lear, Englewood (Zoology)
Grout, A. J., Manatee (Bryology)
Gunter, Herman, State Geologist, Tallahassee (Geology)
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Guy, Landrum H., P. O. Box 2252, Gainesville (Psychology)

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Harper, Roland H., University of Alabama, University, Ala. (Plant Geography)

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†Hayward, Wyndham, Winter Park (Horticulture)
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Heinlein, Julia H., Florida State College for Women (Psychology)
Hinckley, E. D., University of Florida (Psychology)
Hjort, E. V., University of Miami (Chemistry)
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Hubbell, T. H., University of Florida (Biology)
Hull, Fred H., Experiment Station, University of Florida (Genetics)
Hume, H. H., University of Florida (Botany)
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Kinser, B. M., Eustis
Kinsler, Lawrence E., Rollins College (Physics)
Kirk, W. G., Experiment Station, University of Florida (Animal Husbandry, Chemistry)
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Komarek, Roy, Florida Commission of Game and Fresh Water Fish, Tallahassee (Biology)
Kurz, Herman, Florida State College for Women (Botany)
Kusner, J. H., University of Florida (Mathematics, Astronomy)

Laessle, Albert M., University of Florida (Biology, Botany)
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Leigh, Townes R., University of Florida (Chemistry)
†Long, Mrs. Winifred O., 2030 43rd St., St. Petersburg (Botany, Zoology, Geology, Ornithology)

†Associate member.

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Maclachan, J. M., University of Florida (Sociology)
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†Miller, Dorothy B., University of Miami (Zoology)
Miller, E. Morton, University of Miami (Zoology)
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Moor, F. Clifton, Florida State College for Women (Medicine)
Mowry, Harold, Experiment Station, University of Florida (Horticulture)
Mulvania, Maurice, Florida Southern College (Botany)
Murray, Mary R., Robert E. Lee Junior High School, Miami

Neal, W. M., Experiment Station, University of Florida (Animal Husbandry)
Newell, Wilmon, University of Florida (Agriculture)
Newins, H. S., University of Florida (Forestry)
Nissen, Henry W., Yale Laboratories of Primate Biology, Orange Park (Biology)
Norris, H. W., Grinnell, Iowa (Zoology)

Ogden, J. G., Jr., Florida Southern College (Physical Geography)
Osborn, Herbert, Rollins College (Zoology, Entomology)

Parker, Horatio Newton, 2777 Park Street, Jacksonville (Public Health)
Partridge, Sarah W., 508 S. Duval Street, Tallahassee (Biology)
†Pearson, Hazel M., University of Miami (Ecology)
Pearson, Jay F. W., University of Miami (Zoology)
Pearson, Walter M., University of Tampa (Protozoology)
Penningroth, Paul W., St. Petersburg Junior College (Psychology)
Perry, Louise M., Sanibel (Marine Biology, Ornithology)

†Associate member.

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†Phay, John E., P. O. Box 215, Lake Placid (Physics)
Phelps, Willard B., University of Tampa (Natural Sciences)
Phillips, Walter S., University of Miami (Botany)
Phipps, Cecil G., University of Florida (Mathematics)
Ponton, G. M., Florida State Road Department, Tallahassee (Geology)
Raa, Ida, Leon High School, Tallahassee (Chemistry)
Reinsch, B. P., Florida Southern College (Mathematics, Physics)
Richards, Harold F., Florida State College for Women (Physics)
Robinson, T. Ralph, P. O. Box 1058, Orlando
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Rolfs, P. H., 509 E. Church St., Gainesville (Botany)
Rusoff, L. L., Experiment Station, University of Florida (Biochemistry)

Sadler, G. G., 315 N. Highland St., Mount Dora (Zoology)
Sandels, Margaret R., Florida State College for Women (Home Economics)
Scarborough, Mrs. Christine, Florida State College for Women (Psychology)
Schober, J. E., 1175 East 11th St., Denver, Colorado (Physics)
Schornherst, Ruth, Florida State College for Women (Botany)
Scott, George G., 1394 Grove Terrace, Winter Park (Biology)
Senn, P. H., University of Florida (Agronomy)
Shealy, A. L., University of Florida (Animal Husbandry)
Sherman, H. B., University of Florida (Biology)
Sherman, John H., University of Tampa (Social Sciences)
Shippy, W. B., Experiment Station, Sanford (Plant Pathology)
Shudemen, C. L. B., Florida Southern College (Physics)
Simpson, J. Clarence, Florida Geological Survey, Tallahassee (Archeology)
Smith, Cornelia M., Stetson University (Biology)
Smith, Frederick B., University of Florida (Microbiology)
Smith, H. F., Andrew Jackson High School, Jacksonville (Physics, Chemistry, Biology)
Smith, Maxwell, Lantana (Biology)
Smith, Richard M., P. O. Box 212, Tallahassee (Chemistry)
Springer, Stewart, Zoological Research Supply, Englewood (Zoology)
Spurr, J. E., Rollins College, Winter Park (Geology)
St. John, E. P., Floral City (Botany)
St. John, Robert P., Floral City (Botany)
Stevens, H. E., 224 Annie St., Orlando (Horticulture)
Stewart, John A. M., Florida Southern College (Botany)
Stiles, C. Wardell, Rollins College (Zoology)
Stokes, W. E., Experiment Station, University of Florida (Agronomy)
Story, Helen F., 2762 Burlington Ave., St. Petersburg (Astronomy, Mathematics)
Stubbs, Sidney A., Florida Geological Survey, Tallahassee (Geology)
Swanson, D. C., University of Florida (Physics)

Tallant, W. M., Manatee (Archeology)
Tanner, W. Lee, 732 N. W. 36th St., Miami (Chemistry)

Thomas, R. H., 37 S. Hogan St., Jacksonville (Electricity)
Tilden, Josephine E., Lake Wales (Botany)
Tilt, Jennie, Florida State College for Women (Chemistry)
Tisdale, W. B., Experiment Station, University of Florida (Plant Pathology)
Tissot, A. N., Experiment Station, University of Florida (Entomology)
Tracy, Anna M., Florida State College for Women (Nutrition)

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Van Cleef, Alice, Glenwood (Chemistry, Biology)
Van Dusen, A. C., Northwestern University, Evanston, Illinois (Psychology)
Van Leer, B. R., North Carolina State College, Raleigh, N. C. (Engineering)
Vance, Charles B., Stetson University (Geology)
Vance, Earl L., Florida State College for Women (Journalism)
Vermillion, Gertrude, Florida State College for Women (Chemistry)

Waddington, Guy, Rollins College, Winter Park (Chemistry)
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Wallace, Howard K., University of Florida (Biology)
Wallace, Madge, 2725 Lydia St., Jacksonville (Botany)
Waskom, Hugh L., Florida State College for Women (Psychology)
Watson, J. R., Experiment Station, University of Florida (Entomology)
Weber, George F., Experiment Station, University of Florida (Plant Pathology)
Weil, Joseph, University of Florida (Engineering)
West, Erdman, University of Florida (Botany)
West, Frances L., St. Petersburg Junior College (Biology)
White, Sarah P., Florida State College for Women (Medicine)
Williams, Henry W., Drawer C., Umatilla (Herpetology)
Williams, Osborne, University of Florida (Psychology)
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Williamson, R. C., University of Florida (Physics)
Willoughby, C. H., University of Florida (Animal Husbandry)
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Witmer, Louise R., Florida State College for Women (Psychology)
Worchel, Phillip, Florida State Hospital, Chattahoochee (Psychology)

Yothers, W. W., 457 Boone Street, Orlando
Young, John W., 720 Glen Ridge Drive, West Palm Beach (Mathematics, Physics)
Young, William C., Yale Laboratories of Primate Biology, Orange Park (Biology)

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Florida State College for Women, Tallahassee
Rollins College, Winter Park
St. Petersburg Junior College, St. Petersburg
University of Florida, Gainesville
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RALEIGH, N. C.: Van Leer.
COLUMBUS, OHIO: Christenson.
WOOSTER, OHIO: Bangham.
RICHMOND, VA.: Gaskins.

CHARTER OF THE FLORIDA ACADEMY OF SCIENCES[1]

ARTICLE I. NAME. The name of this corporation shall be Florida Academy of Sciences.

ARTICLE II. PURPOSES. The purposes of the Academy shall be to promote scientific research, to stimulate interest in the sciences, to further the diffusion of scientific knowledge, to unify the scientific interests of the state and to issue an annual scientific publication.

ARTICLE III. MEMBERSHIP. Election to membership in the Academy shall be by vote of the Council, upon written nomination by two members.

ARTICLE IV. TERM OF CHARTER. This corporation shall have perpetual existence.

ARTICLE V. OFFICERS. The affairs of the Academy shall be managed by the following officers, to wit: President, Vice-President, Secretary and Treasurer.

ARTICLE VI. COUNCIL. The officers, together with the immediate past President, and such additional members as are provided in the By-Laws, shall constitute the Council of the Academy.

ARTICLE VII. INITIAL OFFICERS. The names of the officers who shall manage all the affairs of the Academy until the first election under this Charter are as follows:

President—Herman Kurz
Vice-President—R. C. Williamson
Secretary—J. H. Kusner
Treasurer—J. F. W. Pearson

ARTICLE VIII. BY-LAWS. The By-Laws of the Academy shall be made, altered, amended or rescinded at any annual meeting by a two-thirds vote of the members present.

ARTICLE IX. INDEBTEDNESS. The highest amount of indebtedness or liability to which the Academy may at any time subject itself shall never be greater than two-thirds of the value of the property of the Academy.

ARTICLE X. REAL ESTATE. The amount in value of the real estate which the Academy may hold, subject always to the approval of the Circuit Judge, shall be $100,000.00

[1]Granted February 24, 1936.

BY-LAWS[1]

DIVISION I. MEMBERSHIP

1. The annual dues shall be two dollars for members, one dollar for associate members, payable in advance.
2. Members or associate members whose dues become one year in arrears shall be automatically dropped from membership, after due notice has been given by the Secretary.
3. All persons who become members of the Academy during the year 1936 shall be designated as Charter Members of the Academy.
4. Individuals or institutions may be granted Individual Sustaining Membership, or Institutional Sustaining Membership, respectively, on terms to be arranged by the Council in each case.

DIVISION II. SECTIONS

1. There shall be such sections of the Academy as the Council may authorize.
2. All section meetings shall be open to all members, but members shall vote concerning section matters only in those sections in which they are enrolled, and no member shall be enrolled in more than two sections, except by permission of the Council.
3. There shall be a Chairman of each section.
4. The Chairman of each section shall be, *ex-officio*, a member of the Council.

DIVISION III. OFFICERS

1. The President shall discharge the usual duties of a presiding officer at all meetings of the Academy and of the Council, and shall give an address to the Academy at the final meeting of the year for which he is elected.
2. The Vice-President shall assume the duties of the President in the latter's absence.
3. The Secretary shall keep the records of the Academy and of the Council and shall act as Managing Editor of the PROCEEDINGS. He shall have charge of the sale and exchange of the PROCEEDINGS. Subject to the approval of the Council he may appoint an Assistant Secretary to assist him in performing his duties.
4. The Treasurer shall have charge of the finances of the Academy.

[1]As amended at the 1938 and 1939 annual meetings.

5. In addition to the officers and section chairmen, the Council shall include the Editor of the PROCEEDINGS, the two most recent past Presidents, the Chairman of each standing committee, and the Chairman of the Committee on Local Arrangements.

   The Council shall exercise general supervision over all the affairs of the Academy in the intervals between meetings of the Academy. Specific duties of the Council shall be:

   a) To be responsible for the publications of the Academy.
   b) To elect members and associate members.
   c) To fill vacancies in any of the offices of the Academy.
   d) To invest the funds of the Academy.
   e) To make recommendations to the Academy in matters pertaining to general policy.
   f) To appoint a nominating committee.
   g) To appoint an auditing committee.
   h) To appoint an Editor, an editorial committee, and a Business Manager of the Proceedings.
   i) To determine affiliation relations of the Academy.
   j) To choose the time and place of meetings of the Academy.
   k) To prepare programs for the meetings of the Academy.
   l) To authorize the formation of Sections of the Academy.
   m) To approve the appointment of the Assistant Secretary.

DIVISION IV. ELECTIONS

1. The officers and section chairmen of the Academy shall be elected at the last session of the annual meeting.
2. The Council shall appoint a nominating committee which shall nominate a candidate for each office named in Section 1, but additional nominations may be made by any member.
3. Officers shall be elected by vote of the members present at the annual meeting.
4. Section chairmen shall be elected by vote of the members enrolled in their respective sections and present at the annual meeting.
5. A plurality of the votes cast for each office shall constitute election.
6. The officers thus elected shall enter upon their duties at the adjournment of the annual meeting.
7. Vacancies which occur in any office or committee chairmanship between annual meetings shall be filled by the Council.

DIVISION V. PUBLICATIONS

1. There shall be published an annual volume to be called the PROCEEDINGS OF THE FLORIDA ACADEMY OF SCIENCES.
2. The PROCEEDINGS shall be under the immediate control of the Council, through an Editor, a Managing Editor, an Editorial Committee of which the Editor shall be Chairman *ex-officio*, and a Business Manager. The Editor, Editorial Committee, and Business Manager shall be appointed by the Council each year for the volume of the PROCEEDINGS of that year.
3. One copy of the PROCEEDINGS shall be supplied free to each paid up member and associate member.

DIVISION VI. FINANCIAL MATTERS

1. The fiscal year of the Academy shall be the calendar year, and the accounts of the Treasurer shall be balanced January 1 of each year.
2. Prior to each annual meeting the Council shall select an auditing committee of two members which shall inspect the financial records of the Academy and report on them to the annual meeting.
3. All orders which involve payment of the funds of the Academy shall be signed by the President and the Secretary.

DIVISION VII. AFFILIATIONS

1. Affiliation relations between the Academy and other organizations may be arranged by the Council on such terms as it may decide in each case, subject to the approval of the annual meeting.

DIVISION VIII. MEETINGS

1. There shall be at least one meeting of the Academy annually.
2. The time and place of the meetings shall be determined by the Council.
3. Meetings shall be conducted under Roberts' Rules of Order.
4. At least thirty days written notice of each annual meeting shall be given.
5. The Council shall be the program committee for the general sessions at any meeting. The Secretary together with the chairman of each section shall constitute the program committee for that section.
6. At any meeting of the Academy of which thirty days notice has been given, those present shall constitute a quorum; at other meetings, one-fourth of the members.

DIVISION IX. AMENDMENTS (AS PROVIDED IN CHARTER)

1. By-laws may be made, altered, amended or rescinded at any annual meeting by two-thirds vote of the members present.

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